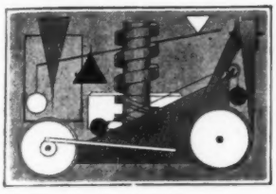
MACHINE DESIGN

as it affects

ENGINEERING–PRODUCTION–SALES

Volume 4 **November, 1932** **Number 11**



Forthcoming ISSUES

MUCH will be said and done in the near future in the matter of styling machines. The alert engineer is beginning to appreciate (many have already) that sound mechanical design alone will not create a market.

Fortunately mechanical engineers have at their disposal the services of a group of qualified artist design consultants who specialize in styling, appearance and finish. One of these, outstanding in his field, is the author of an informative article to appear shortly.

L. E. Jermy

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Published on the tenth of each month. Subscription rates: U. S. and Possessions, two years $5; one year $3. Single copies, 35 cents. Canada, two years $6; one year $3.50, including duty. Europe, two years £2; one year £1.4.0.

THE JOHNSON PUBLISHING CO., PENTON BUILDING, CLEVELAND, OHIO

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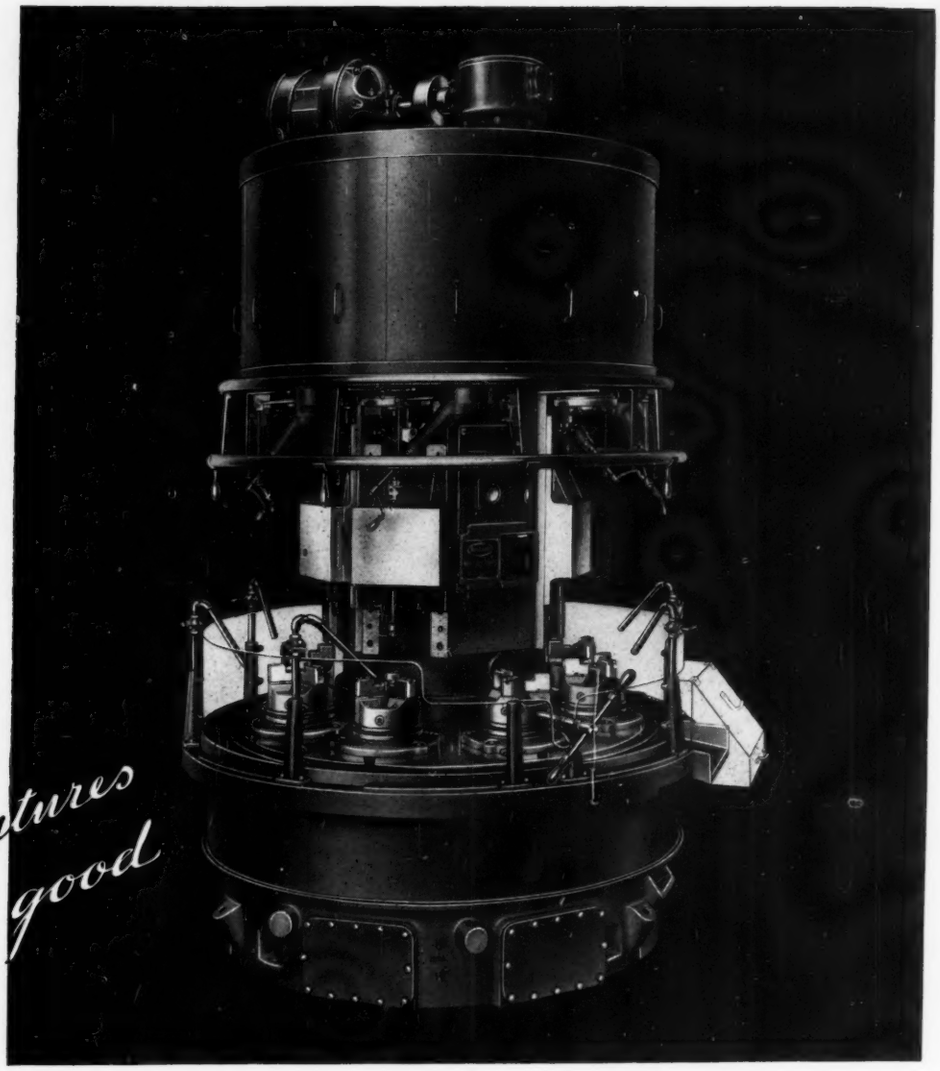
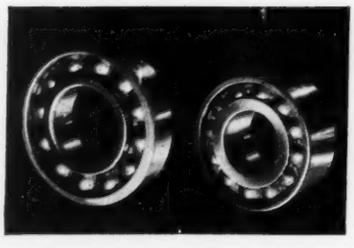


New Departures had to be good

. . . to gain the acceptance of Bullard

engineers and to maintain the high Mult-Au-Matic standards of accuracy, efficiency, and ability to stand-up under the severe stress of modern machining requirements. ✣ ✣ ✣ In Type "D" 8-Spindle Mult-Au-Matic, 98 New Departure Ball Bearings eliminate wear, increase years of useful life with economy of upkeep, assure an efficient ratio between input and delivered power with attendant savings, and provide smooth operation at the point of cutting. ✣ ✣ ✣ Nothing contributes more to the character and performance of a machine than good bearing engineering. New Departure engineers worked hand in hand with Bullard's in achieving this high efficiency. Every machine builder is invited to make use of this important branch of New Departure service. . . . .



NEW DEPARTURE BALL BEARINGS

The New Departure Mfg. Company, Bristol, Conn.

Itemized Index, November, 1932

Key: Edit. Editorial Pages; Adv. Advertising Pages; R, Right hand column; L, Left hand column

Compiled for the assistance of engineers confronted with specific design problems

THROUGH the steady advance of civilization, man constantly is gaining new knowledge with which to improve his position. In industry his facilities for creating and developing new means of performing work are expanding rapidly. Almost daily new methods and new materials are made available for his use.

In this machine age, it is becoming increasingly necessary that those who are responsible for designing mechanical equipment be informed of the progress in machine design in all industries. More and more it is important that the ideas developed for one type of machinery be carefully scrutinized for possible application to other types. Today, to a greater extent than ever before, design is universal.

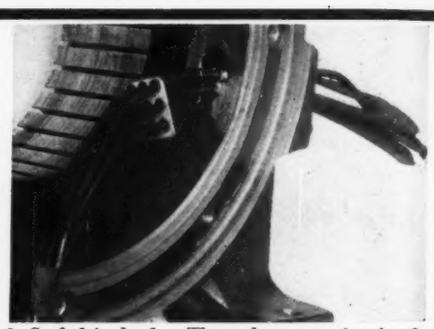
Explanations are bad in this market!

WHEN plants and machinery were working at full capacity, motor failures were serious enough. But with plant operation at partial capacity, when a plant has to produce merchandise quickly and is *halted* by a machine with a faulty motor—then, explanations are bad.

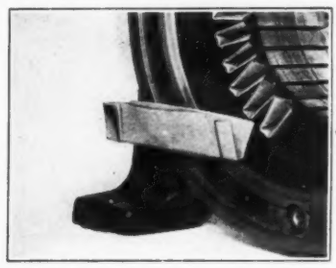
And it can't be explained easily. Always in your customer's mind the motor, whatever the make, is part of your machine—and he holds you responsible.

In these times of *extra* values, additional worth into its motors. Fairbanks-Morse is putting Construction features which enable you in turn to offer greater values to your sales prospects. Features which give added dependability and avoid the necessity of explanation for failure.

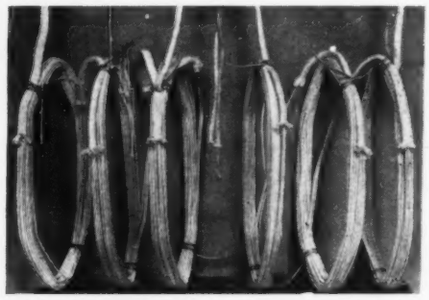
A *few* of these features are shown in the column at the right. The complete story of extra value in Fairbanks-Morse Motors will be sent on request. Fairbanks, Morse & Co., 900 South Wabash Ave., Chicago. 32 branches at your service throughout the United States.



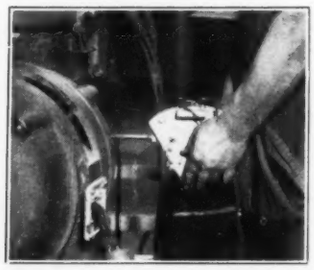
1. Sealed-in leads. Through an opening in the frame—and there anchored permanently with a special sealing compound. The roughest kind of handling during installation or afterward cannot put strain on the stator winding connections.



2. Special cuff insulation. Empire cloth inside of two special pre-formed fibrous sheets is inserted in the stator core slots. An ingenious method of folding makes a self-locking cuff and gives permanent protection from slippage and added protection to the windings.



3. Group wound coils. A phase group winding from one piece of wire—reduces end connections and eliminates a source of mechanical failure. Lead connections from these phase windings are *welded*, not soldered or brazed. An innovation in winding construction that keeps motors out of the repair shop.



4. Every motor is given a thorough vibrometer test to make sure of proper running balance. Eliminate vibration and you reduce to a minimum the wear on bearings. Sealed-ball bearings and smooth running insure trouble-free service from F-M Motors under severest operating conditions.

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POWER PUMPING AND WEIGHING EQUIPMENT

5728-EA 40.47

MACHINE DESIGN

THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO

November, 1932 Vol. 4—No. 11

Ingenuity Essential in Combating Temperature, Pressure

By Robert R. Harkins

HIGH temperatures and pressures inherent in certain types of equipment confront the designer in the selection of metals and packings and method of lubrication. Problems of this nature apply especially to the development of centrifugal and reciprocating hot oil pumps. Choice of proper metals not only involves the strength of the material at the temperature and pressure at which it is used, but difficulties arise also from unequal expansions and contractions encountered when the pump changes from room temperature to operating temperature and back. Erosion and corrosion caused by the fluid handled are other factors to be combated.

Similar problems are encountered by designers of steam turbines, internal combustion engines, ore smelting apparatus, fans, glass forming machines and other types of machinery in which temperature, corrosion and erosion must be considered.

When possible, alloys should be employed for this class of equipment with coefficients of expansion and thermal conductivity equal to low carbon steel. If alloys having a conductivity in excess of that for steel at operating temperatures could be secured, this would be most desirable. In general, however, alloys have lower conductivities than the pure metals. This is particularly true of the present high temperature, corrosion-resistant materials.

Thermal coefficient of expansion is of importance inasmuch as it determines to a large extent the types of materials which can be used together. In a hot oil pump it is desirable to make the wearing parts such as impellers, sleeves, etc.,

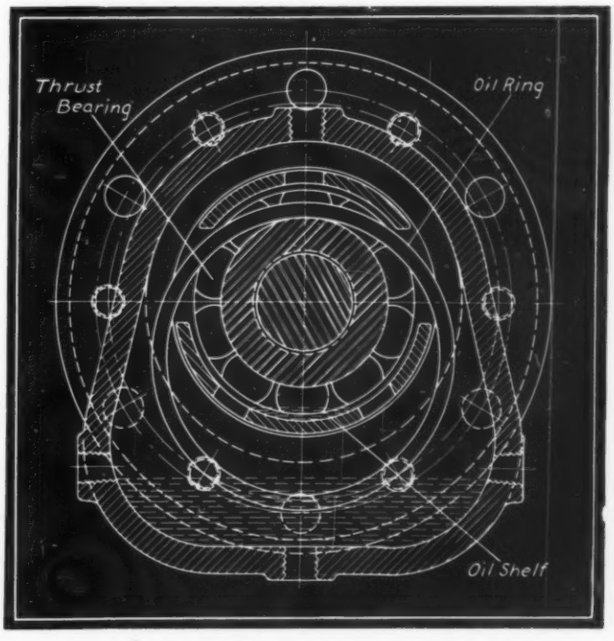

Fig. 1 — Thrust bearing of the ball type employed on centrifugal hot oil pump incorporates an oil ring that carries oil to a shelf by which the proper level is maintained. Excess oil returns to the reservoir below

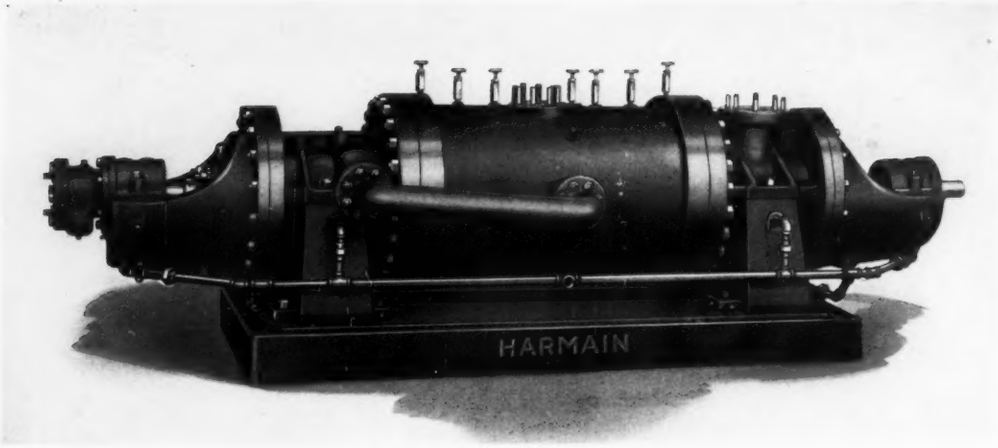

Fig. 2—Compactness characterizes the design of this centrifugal type pump which was developed to take the place of reciprocating units in handling hot oil in refineries. The barrel is made of electric alloy cast steel. End covers are of the same material to obviate unequal expansion

from corrosion-resistant alloys, while the pump blocks or barrels may be constructed from much cheaper material if the difference in expansion between the various parts is not too great.

Selection of materials is only one of many factors which the designer of hot oil pumps must study. Even with materials of equal conductivity and the same coefficient of expansion careful allowance must be made so that no deformation of the machine will be created due to the parts not remaining at similar temperatures. This applies especially to the design of a hot oil centrifugal pump, and certain parts necessarily must be water cooled to give proper operating satisfaction.

Centrifugal Unit Is Compact

With these considerations in mind, Harmain Engineers Inc., affiliated with National Steam Pump Co., Upper Sandusky, O., have developed a centrifugal pump, Fig. 2, for handling oil up to 800 degrees Fahr., with capacities ranging from 150 to 600 gallons per minute and for pressures up to 2000 pounds. From the standpoint of size the completed unit stands in striking contrast to the huge reciprocating pumps formerly used to handle hot oil. Compactness is a natural function of this type of design. There is a distinct saving in the size of the building and the foundations required for installation of the pump, and the equipment can be controlled readily by a flow meter mounted on the main control panel of the operating room.

The sectional view, Fig. 4, shows the web on the lower part of the head which slides in a groove in the foot and retains the pump centerline from side shift on the pump base. These feet which are mounting standards are water cooled from the same system as the main shaft bearings. A second system of water cooling is used for preventing heat from the hot oil from being transmitted along the pump shaft to the main bearing. This operates as follows. Bolted in the end of the pump is a packing box with a gasket at the rear. The water flows around this box, even in the rear of the packing, so that any movement of the oil through the packing must first pass over a cold surface. After the water leaves the packing box, it circulates into the gland and strikes the sleeve on the shaft. Any oil which might leak through the packing passes into this water. The water which is likely to

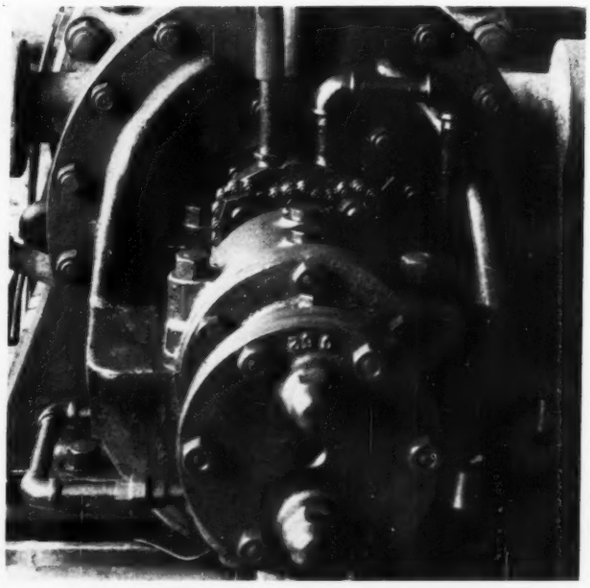

Fig. 3—An endless chain around sprocket nuts insures uniformity in tightening packing gland

come in contact with oil is kept separate from the water that cools the bearings, standards and base so that it can pass to an oil trap. The other cooling water is conducted to an outlet after it has completed its cycle.

Every precaution must be taken in this type of unit to prevent possibility of hot oil escaping. To accomplish this a sleeve on which the packing rides is keyed to the shaft. One end of this special sleeve overlaps a bronze sleeve, Fig. 6, on which the gland rides, forming a small packing box which provides a seal between the shaft and the special sleeve. The bronze sleeve contacts the cooling water but not the hot oil. An auxiliary gland on the front of the primary gland

prevents the water from being thrown by the revolving shaft. Both sleeves can be removed without dismantling the pump.

Primary packing glands are split so that the gland can be removed entirely while adjusting the packing. Adjustment of the gland is accomplished by four bolts, provided with a fine thread on which sprocket nuts are screwed, these nuts being connected by an endless chain as shown in Fig. 3. This insures equal adjustment of all four nuts and keeps the gland parallel with the shaft, requiring the screwing up of only one nut to make the packing adjustment. Thus a great deal of packing trouble is obviated which otherwise might be caused by faulty adjustment.

Cast Steel Barrel Employed

With reference to Fig. 2, disclosing the exterior design, it will be noted that the barrel is of simple cylindrical shape, the outer case of the pump being constructed to withstand high pressure. It is made of electric alloy cast steel, heat treated and quenched to prevent distortion when operating under high temperature. A cast instead of a forged barrel is used because in the first place a casting, in this application, offers less tendency to creep and distort. Moreover, it was desirable to construct both the barrel and headers or end covers of the same material in order to maintain uniformity in thermal conductivity and coefficient of expansion. In view of the complicated design of the end covers, forging of which would be virtually impossible, the casting process offered the best solution.

Suction and discharge openings are separate from the barrel thus eliminating unequal metal sections and simplifying the founder's problem in obtaining a sound casting. Suction and discharge adapters are placed in a vertical position and on the centerline, forestalling vapor binding and simplifying the piping arrangement.

In the case of the pump shown in Fig. 4, this having four stages, two impellers take the oil from the suction entrance and carry it to a pipe by which it is transmitted to the other end of the pump, from whence it is taken by the remaining two impellers to the discharge pipe. In other words this unit is of the opposed impeller type.

End covers are bolted to the barrel with a male and female joint to insure correct alignment under varying temperatures and pressures. These end covers carry on their centerlines the supporting brackets of the pump. Because suction is applied at one end of the pump, only the pressure thus created is carried on the packing at that end. The end cover opposite the suction opening carries only half the pressure of the pump inasmuch as half the number of impellers finally force the oil to the discharge opening. Between the packing box on this end and the pressure chamber a valve is installed, and between this valve and the packing box there is a return pipe to the suction end, so that the packing on the end opposite the suction opening has but little more than suction pressure. Any oil which might leak past the valve is, of course, returned through the equalizing pipe to the suction opening.

Opposed Impellers Solve Problem

Difficulty is experienced in the design of a multi-stage centrifugal pump in taking care of the end thrust. However, the opposing of the impellers tends to solve the most difficult part of this problem. In a pump which is designed for opposed impellers and is fitted properly, the pump will operate without thrust with the ex-

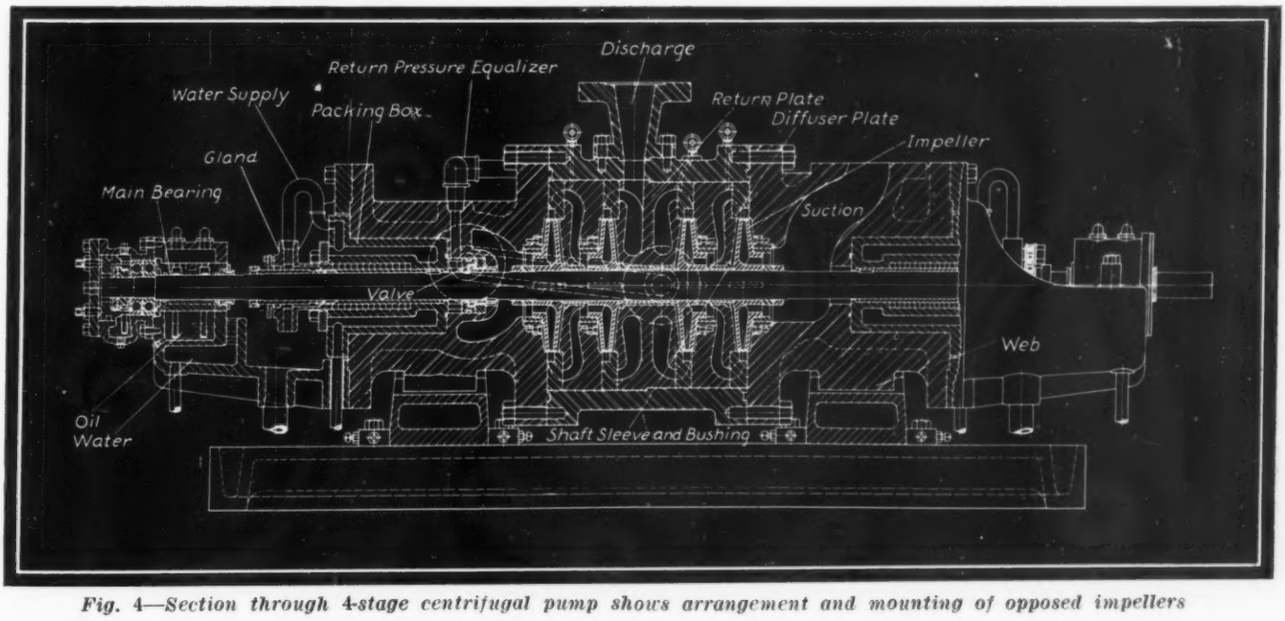

Fig. 4—Section through 4-stage centrifugal pump shows arrangement and mounting of opposed impellers

ception of minor surges caused by uneven fluid flow.

The thrust bearing, of the ball type, Fig. 1, is required to take only the surges from the flow, and is capable of withstanding the most severe thrust this pump could impose. It is, however, loaded lightly under normal conditions. Most ball bearings suffer from either too much or too little oil; the design of this bearing is one method of solution. The bearing is ring oiled which is unusual, many bearings being designed to dip in the oil. It is hard, however, to design a proper pocket for the bearing to dip into and at the same time retain a proper oil level. This bearing actually dips into the oil, but the level is separate from the reservoir below the bearings, and is maintained continually on a shelf by the action of the ring and overflow as depicted in Fig. 1. Main radial bearings are of the sleeve type, made from lead bronze alloyed for high speeds; they are water cooled and lubricated by two large rings in each bearing.

Hot Oil Presented Bearing Problem

Design of the shaft which carries the impellers presented one of the most difficult problems encountered in the development of the unit by reason of the fact that the shaft is required to rotate in the hot oil being pumped. This necessitates bearings which will function satisfactorily under these conditions. Sleeves of a nonferrous alloy offering high resistance to abrasion fastened on the shaft and running in special alloyed cast iron bushings finally were selected.

Impellers and shaft sleeves are not forced on the shaft, but can be slipped on and off easily by hand. Aside from being readily removable from the shaft there are other reasons for this method of fastening. Strains tending to distort or bend the shaft would be caused by an impeller with a tight key, and the mechanical balance of the impellers could not be maintained if they were thus fastened to the shaft.

Opposing of the impellers and the shoulder in the pump barrel allows sealing of the return plates, Fig. 4, by the diffuser plates which act as sealing surfaces on the side of each return plate. These surfaces are held tightly by the liquid pressure acting on the plates and it therefore is unnecessary to fit the entire surfaces of the peripheries of the return plates to the barrel to prevent leakage. The return plates are supported in the barrel by small raised portions which are provided for holding them concentric with the barrel while facilitating easy withdrawal in disassembling the pump.

In addition to the features of compactness, ease of assembly, etc., the pump was designed to be of the centrifugal type rather than the reciprocating for the following reasons. Action of the surge of a plunger pump is but little understood. The difficulty lies in the high pressure set up by elastic oscillations produced first by plunger action. If the pressure variations produced by these elastic oscillations find no reflecting point, they will die out. If, however, they are reflected in any manner from any point in the line, the resultant pressure will depend on the phase relation of the incident and reflected waves, with the inertia effect added, and high pressures will be produced. These pressures have frequencies too high to be registered on a pressure gage and consequently they seldom are recognized even by the trained engineer. The troubles caused by this action often are attributed to faulty material in tubes and headers. Employment of the centrifugal principle solves this problem of oscillation as well as many other difficulties not thoroughly understood by engineers.

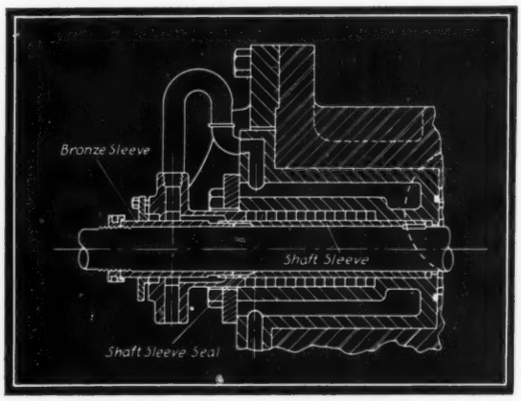

Fig. 6—A special sleeve overlapping a bronze sleeve provides a small packing box for sealing

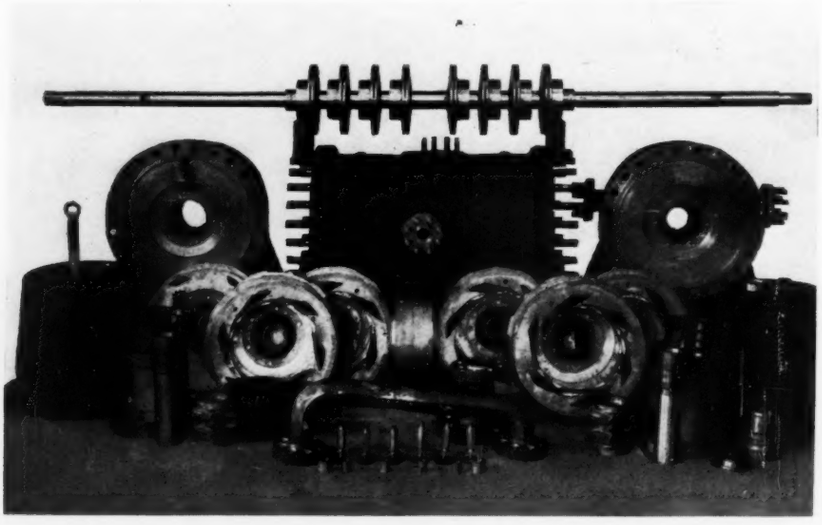

Fig. 5—Exploded view showing parts which make up 8-stage pump

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

Machine Parts of Powdered Metal

POWDERED metallurgy utilizing metals in the powdered rather than molten state is winning the attention of engineers. The new method not only makes possible the manufacture of oilless bearings of heavy load carrying capacity but the fabrication of other machine parts from common alloys. Mixtures of metals which would be difficult to pour because of their difference in melting points or their chemical reactions have possibilities when processed in powder form.

Instead of being poured into molds metals can be shaped at low temperatures by powdered metallurgy. One advantage of objects made by this process is their lightness. Inasmuch as the finished part is in effect a metal sponge, its specific gravity is considerably less than solid metal, though with almost no difference in strength. At present the greatest obstacle to development of this practice is the difficulty of making large objects. As the diameter or area of the article increases, the total pressure required also rises considerably.

Processing of the powdered metal part is performed by mixing, briquetting, heat treating and finishing. Heat treating is carried out by the sintering method which means that the temperature exceeds the melting point of only one of the elements. In the case of the graphited bushings, Fig. 1, produced by the Amplex Mfg. Co., Detroit, the temperature exceeds the melting point of the tin but does not approach that of the other constituent, copper. Powdered copper for bearing requirements is made from two processes, namely, by the reduction of pure copper oxide and pulverizing, or by electroplating in the form of "rotten copper."

Develops Self-Consuming Welding Rod

INDUSTRY is looking to welding processes for faster and more economical means of fabrication of machines and their components. A specific instance in which a pioneer manufacturer saw this movement taking place lies in the development of a new welding process by Champion Rivet Co., Cleveland. The method consists of a simple arrangement which holds a self-consuming welding rod against the joint to be welded.

Electrical control devices are practically eliminated. The paste-coated rod is laid down in the angle formed between the sections to be welded and the current applied through a series of electrical contacts which are made by arms extending from a bus bar. Several years ago self-consuming rod was originated for welds up to about 18 inches in length; with the new process, however, welds of any length can be made. Included in the applications to which the process is expected to be suitable are the manufacture

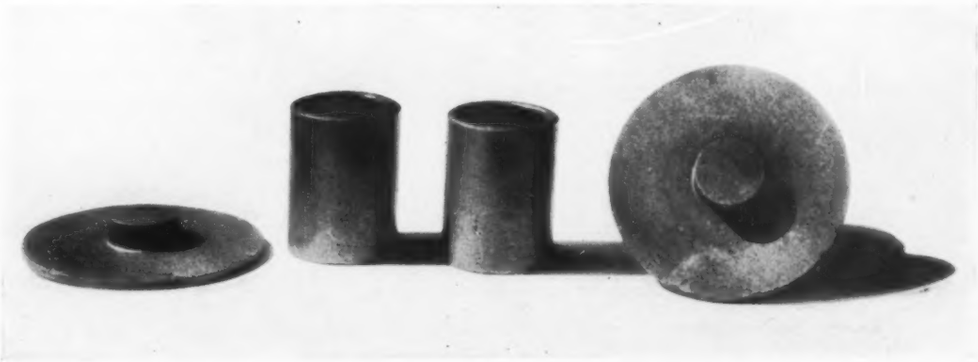

Fig. 1—Pure copper in the powdered form constitutes the basis of the oilless bushings depicted in center. Spring disks as shown at ends also are manufactured by the process involving powder metallurgy

of steel tubing, production of frames for large machines, oil storage tanks, etc. Steel building construction also holds promises for its use.

Controlling Temperature of Oil

LUBRICATION effective to the highest degree is obtainable only when the oil temperature is regulated if the equipment is subjected to contrasting temperature changes. This condition applies particularly to automobiles which are required to operate under varying weather conditions. From this standpoint and in view of the increasing attention being paid to lubrication of machinery, Leon Cammen, New York, has developed an oil temperature regulator, Fig. 2. The device consists of a heat exchanger with oil flowing through tubes and water circulating in the space in the casing surrounding them.

When the cold engine is started the water heated in the engine jacket passes through the casing as indicated by the arrows in the top drawing, Fig. 2. The oil consequently acquires a higher temperature from the warm water in the casing. After the oil in the crankcase reaches the desired working temperature a thermostatic device combined with the oil filter, moves three valves, *a*, *b* and *c* of the heat exchanger through an angle of 90 degrees. At this point the water cooled in the radiator passes through the heat exchanger as indicated by the arrows in the lower drawing.

Reversal of the water circuit thus heats the oil when the engine is cold and cools it when hot. Mr. Cammen claims that in his oil temperature regulator the oil is heated up to 100 degrees in two or three minutes, whereas earlier devices have been much slower in action.

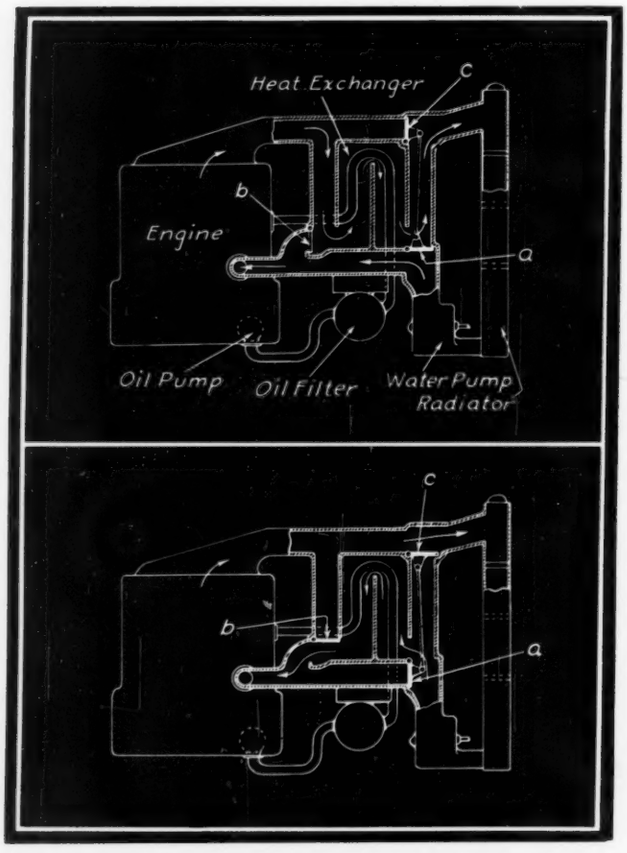

Fig. 2—(Top)—Position of valves in oil temperature regulator when engine is cold. (Bottom)—Valves change position to cool oil of heated engine

Counter Currents Mix Materials

UNLESS careful study is given to the directional characteristics of the currents set up by the moving blades in a mixing machine there is possibility of failure in securing a perfect mixture. One efficient unit of this type, a counter-current rapid batch mixer, now is being manufactured in this country under the Eirich patent by Lancaster Iron Works, Lancaster, Pa.

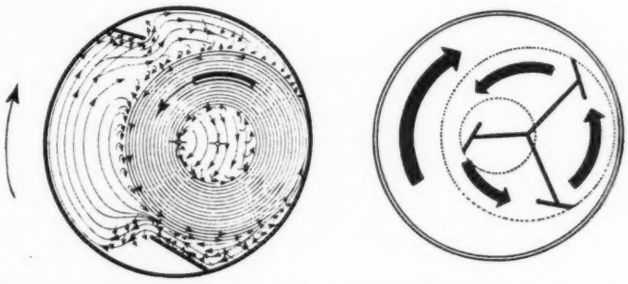

Fig. 3—Diagram at left shows direction of currents in mixer. (Right)—Layout of single star unit

Mixing arrangement consists of an open or enclosed type pan, rotating on four trunnion wheels, which feeds the batch continuously to the mixing star, turning in the opposite direction. As shown at the right in Fig. 3, this being the single star model, the mixing star is eccentric to the pan and is provided with a number of spring-mounted steel blades placed in such a manner as to give the maximum number of points of intersection during its rotation.

Speed of the pan to the mixing star is 1 to 5. The thin layer of material in the pan is carried by the counter-current action at a moderate speed toward the rapidly rotating mixing star. The diagram at the left, Fig. 3, shows that at the points of intersection of both movements at the periphery of the mixing blades, the batch materials are turned on vertical axes. The effect is increased considerably by the vertical side scraper and corner blades which are stationary, thereby forcing the batch through a narrow passage.

Filament Coil Less Than Hair Size

TUNGSTEN filament wire used in the six-watt incandescent lamp is so fine it is practically invisible, being only four ten-thousandths of an inch in diameter. After it is coiled, 1390 turns

per linear inch, to form the spring-like filament through which the electricity flows to produce light, the outside diameter is less than that of a human hair.

All six-watt filament wire employed in the Westinghouse lamp is drawn from a bar of tungsten metal 3/8-inch square, 24 inches long and weighing 1-1/3 pounds. The bar passes through 95 dies, each with an aperture slightly smaller than the preceding one. Nearly two-thirds of these dies are rough cut diamonds in which holes have been drilled.

When being drilled the diamonds are placed in revolving spindles, and extraordinarily hard steel needles, dipped in diamond dust, press against them at the center. The hole is conical in shape and is drilled half-way through both sides of the diamond. Where the apex of each cone meets, barely enough to break through, the tiny hole forms the die.

Utilizing Box-Type Construction

BOX-TYPE construction to attain rigidity in machine construction is a feature no designer should overlook when the unit being planned or considered for redesign lends itself to this type of layout. The setup becomes even more desirable when a brace for example can be utilized for the lubrication reservoir as in the new Gridley four-spindle automatic, Fig. 4, just announced by National Acme Co., Cleveland. The

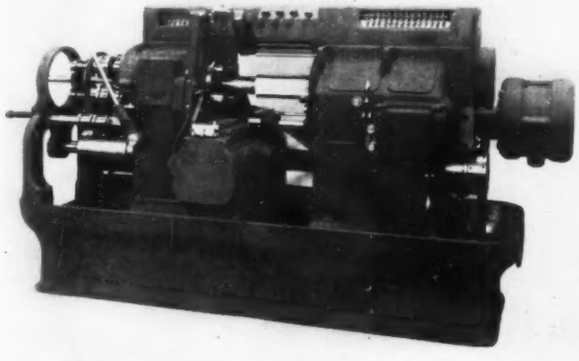

Fig. 4—Top brace is of rigid box-type construction and provides oil reservoir for lubrication system

frame and pan of the new model also are of box form, with a heavy top section to tie the gear section to the spindle frame, making the entire machine a rigid unit.

Forced feed automatic lubrication independently controlled to each bearing is an outstanding characteristic. The system which accommodates all parts of the machine, employs a lubricating pump located in the top section directly over the gear box to force oil to a series of visible oilers. From there a separate copper tube is connected to each bearing. When the unit is stopped the pump discontinues supplying oil to the visible oilers; consequently there is no waste of lubricating oil while the mechanism is idle, even though the oilers may be open.

Porcelain Affords Protective Coating

APPLICATION of porcelain similar to that used on plumbing materials, for coating the component parts of deep well turbine pumps, is a development which engineers of the Johnston

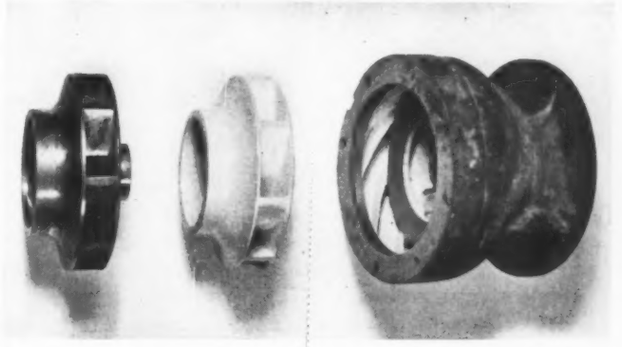

Fig. 5—Porcelain enamel is used for protecting centrifugal pump impellers and bowls from acids and abrasives

Pump Co., Los Angeles, have been studying for several years. Recently the company announced that it had devised an ingenious method whereby the impellers and bowls, Fig. 5, can be coated evenly. The porcelain coating is said to increase the efficiency of pumps approximately 5 per cent in addition to being completely acid and abrasion resistant.

Pump impellers and associated parts as a rule give pump manufacturers more or less trouble in selection of materials. Modern industrial requirements call for units that will handle liquids such as acids, hot oil, water containing abrasives, etc., all of which demand pump materials that will resist destructive effects. As brought out by the Johnston company, it has been necessary for manufacturers to rely almost solely on castings from which it has been difficult to obtain pump runners with an absolutely smooth wear-resisting surface, not merely on the exterior, but throughout the runners and bowls. It is believed that porcelain enamel coating will prove the solution and patents to cover the method have been applied for. Surface tension characteristics of the porcelain, when in a molten state, cause it to flow into the pores of the iron and produce a glass-hard, glass-smooth surface.

Although a separate Schwitzer-Cummins supercharger was used (page 24, October issue) on each bank of cylinders on the multiple engines employed on Gar Wood's record breaking speed boat, MISS AMERICA X, a single carburetor common to both banks was utilized for each engine.

Correcting for Fluid C in Hydraulics

By James I. Clower
and
Harold F. Shepherd

IN TIMES past only physicists and other scientists were concerned with the compressibility of liquids. This question, however, is no longer a matter of purely academic interest since the attention of the engineer has been attracted forcibly to it by the following factors:

Rapid development of the diesel engine

Comparatively recent introduction of hydraulic drives and feeds to various machines, stimulated greatly by development of the constant speed, variable stroke pump

Demand for high speed hydraulic presses

Various research investigations on the viscosity of oils subjected to high pressure.

Today, engineers are giving more consideration to the fact that considerable pump displacement, time or energy may be expended in compressing the liquid used as a hydraulic medium. One or the other of these losses may be harmful or the three factors may add collectively to the first cost, the operating cost or the output of hydraulic apparatus.

It has been assumed quite generally that the specific volume of a liquid does not change appreciably when subjected to pressure and hence the equation $W = PV$ has been used for calculating the hydraulic work where,

W = work of displacement per pound of fluid
P = pressure increase
V = initial specific volume

The diagram at left in Fig. 1 is characteristic of these relations within the pump or motor cylinder when handling an incompressible fluid.

This equation is not sufficiently accurate for all conditions. Water, it has been stated, is approximately one hundred times as compressible as steel and fifteen times as elastic as mercury. Many oils are rather more compressible than water when subjected to the same conditions of pressure and temperature.

This characteristic requires work of compression upon the liquid before it is possible to effect the work of displacement. An indication of this is given at right in Fig. 1. Fuel compressibility is a vital matter in diesel engine design. Dr. Diesel had to abandon direct injection of fuel and to blow the fuel in with air because in his lifetime the hydraulics of solid fuel injection were not developed.

In the present solid injection diesel engine the fuel is raised to the required discharge pressure of 4000 to 6000 pounds per square inch by cam-operated pumps. Fig. 3 shows schematically the system which serves to meter and inject the small charges of fuel. The fuel pressure opens the nozzle valve c which it tends to eject from its bushing, this force being resisted by spring d. Often from one-fourth to one-half of the plunger displacement is required to compress the fuel to the discharge pressure.

Like most adverse properties of material, com-

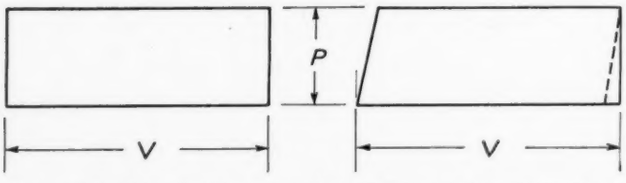

Fig. 1—Representation of specific volumes of incompressible and compressible fluids subjected to pressure

TABLE I
Coefficient of Compressibility of Water

Temperature Degrees Cent.	Pressure Atmosphere	Compressibility per Unit Volume per Atmosphere
0	1 — 25	52.5×10^{-6}
10	1 — 25	50.0×10^{-6}
20	1 — 25	49.1×10^{-6}
0	25 — 50	51.6×10^{-6}
10	25 — 50	49.2×10^{-6}
20	25 — 50	47.6×10^{-6}
0	100 — 200	49.2×10^{-6}
10	100 — 200	46.1×10^{-6}
20	100 — 200	44.2×10^{-6}
50	100 — 200	42.5×10^{-6}
100	100 — 200	46.8×10^{-6}
0	1 — 500	47.6×10^{-6}
20.4	1 — 500	43.4×10^{-6}
48.85	1 — 500	41.6×10^{-6}
0	500 — 1000	41.6×10^{-6}
0	1000 — 1500	35.8×10^{-6}
20.4	1000 — 1500	33.8×10^{-6}
48.85	1000 — 1500	32.5×10^{-6}
0	1500 — 2000	32.4×10^{-6}
0	2000 — 2500	29.2×10^{-6}
0	2500 — 3000	26.1×10^{-6}
48.85	2500 — 3000	25.4×10^{-6}

Compressibility

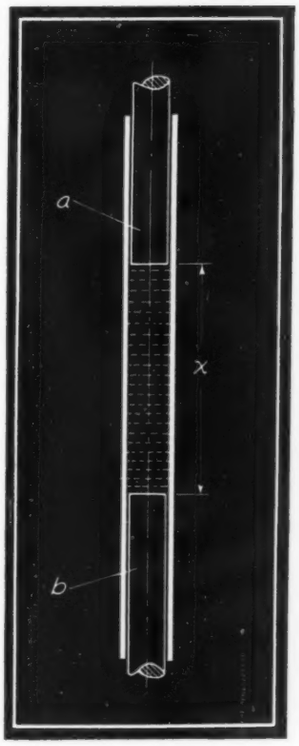

Fig. 2—Simple plunger moving in an endless cylinder at constant velocity characterizes any multicylinder hydraulic pump

pressibility may serve the designer's purpose in some ways. The diesel engine fuel pump designer takes advantage of the interval of fuel compression to accelerate the fuel pump plunger from rest to the speed required for constant pressure injection through the fixed nozzle orifice.

Unless checked by some feature of the design, discharge continues by expansion of the compressed fuel after the plunger movement has ceased. This action is avoided by use of a bypass valve actuated by the pump plunger.

Pumps for fuel injection are a special design problem but possibly the studies of liquid compressibility made in perfecting their design may be of use in planning other hydraulic apparatus.

A. E. H. Love (see bibliography) has stated, "the elasticity of a fluid is always expressed by means of a single quantity of the same kind as the modulus of compression of a solid body. To any increment of pressure which is not too great there corresponds a proportional cubical compression, and the amount of this compression for an increment δp of pressure can be expressed as $\delta p/k$. The quantity that usually is tabulated is the reciprocal of k, and it is called the coefficient of compressibility. It is the amount of compression per unit increase of pressure. As a physical quantity it is of the same dimensions as the reciprocal of a pressure (or of a force per unit of area). The pressures concerned usually are measured in atmospheres (1 atmosphere = 1.014×10^6 dynes per square centimeter). For water the coefficient of compressibility, or the compression per atmosphere is about 4.5×10^{-5}. This gives for k the value 2.22×10^{10} dynes per square centimeter. Young's modulus and the rigidity of a fluid are always zero."

It is to be noted that the modulus of compression, even that of a solid, is a quantity "of the same kind" as Young's modulus but not numerically equal to it as has been stated in some works on hydraulics. Again quoting from Love, this time regarding solids, "the modulus of compression k of an isotropic material is connected with the Young's modulus E and Poisson's ratio σ of the material by the equation

$$k = (1 - 2\sigma)\ E/3$$

Thus the bulk modulus or modulus of compression of steel is given in the Smithsonian Physical Tables as 21.61×10^6 and not as 30,000,000 pounds per square inch, the value often used in comparing the compressibility of steel and water in engineering handbooks.

Love qualifies his statement regarding the proportionality between applied pressure and compression to "any increment of pressure which is not too great." If early experimenters had conceived the necessity of extending their researches to the extremely high pressures in commercial use today, we might not have been taught that the coefficient of compressibility is in any wise similar to Young's modulus.

Table I shows the coefficient of compressibility of water under various conditions. From this it is quite evident that the values given are averages for the range of each experimental test. Compressibility of water as well as that of oils and other liquids varies with temperature and pressure, in a general way decreasing as both temperature and pressure increase. Our present sources of information give only average values at a few temperatures for certain pressure ranges and note a few idiosyncrasies such as the fact that water shows a minimum compressibility at about 50 degrees Cent.

TABLE II

Properties of An Average Fuel Oil

Pressure Range Atmospheres	Compression per Unit Volume per Atmosphere
0 — 51	60.7×10^{-6}
0 — 102	53.4×10^{-6}
0 — 153	50.7×10^{-6}
0 — 205	48.5×10^{-6}
0 — 256	49.7×10^{-6}
0 — 306	49.4×10^{-6}
0 — 352	48.2×10^{-6}

D. E. Alexander derived the date from which Table II is made for an average sample of fuel oil which is used often as a hydraulic medium because of its cheapness and nonfreezing properties.

The compressibility of petroleum fractions

varies rather greatly and inversely with their gravity. Thus Bartoli gives for the range 0-1 atmosphere the value 159×10^{-6} for C_6H_{14} (Hexane, a light constituent of gasoline) and 75×10^{-6} for C_6H_{34} (Hexadecane, a constituent of any paraffin base fuel oil). These values are at 23 degrees Cent. However, the Alexander table will serve any technical purpose.

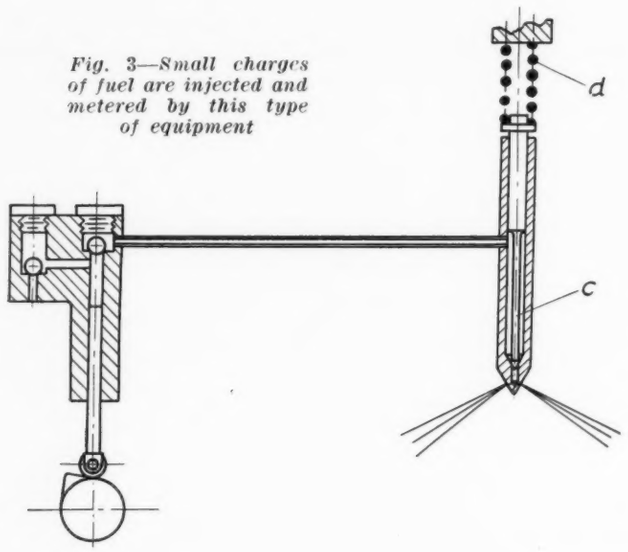

Fig. 3—Small charges of fuel are injected and metered by this type of equipment

Glycerin is the least compressible of fluids used for hydraulic work but no adequate tables seem to exist. Quincke is the authority for value 25×10^{-6} at 20.5 degrees Cent. No pressure range is mentioned. The value 22×10^{-6} at 14.8 degrees Cent. is given by deMetz also without reference to pressure.

Mercury which might have some possibilities for small and exacting mechanisms is comparatively inelastic. The value 3.92×10^{-6} at 0 degrees Cent. is given by Amagat.

Table III shows general physical and chemical properties of a number of liquids which might be used as hydraulic mediums. Certain of them for instance water, castor oil and mineral oil *D* may be chosen by the designer for his work. It is then desirable to make a general empirical formula of sufficient accuracy for ordinary design purposes. One of these may be derived as follows. Taking the higher values of the three liquids suggested.

Water 390,000
Castor oil 380,000
Mineral oil *D* 350,000

we find the average modulus to be 373,000. Then the following is true

$$S_f = \frac{1}{373{,}000} p + S_o$$

where

S_f = specific gravity at pressure p
p = pressure in pounds per square inch
S_o = specific gravity at atmospheric pressure

Furthermore, it is obvious that the change in volume is inversely proportional to the change in specific gravity. Hence, the final volume may be determined by means of the following equation

$$V_f = \frac{V_o \times S_o}{S_f}$$

where

V_f = final volume
V_o = original volume
S_o = original specific gravity
S_f = final specific gravity

Equating V_o equal to unity then combining these two equations and solving for final volume,

$$V_f = \frac{373{,}000\ S_o}{373{,}000\ S_o + p}$$

The foregoing equations are applicable to liquids in which the temperatures do not exceed 400 degrees Fahr. Above this temperature, the isothermal curves derived from these equations and shown in Fig. 4 deviate considerably from straight lines.

The elementary conception of hydraulic transmission is the simultaneous translation of the motion of one moving element, the pump to another, the motor, the connecting link being a fluid. The relative velocities of the pump element and the motor element vary as their piston areas, the displacements being necessarily equal. Length and diameter of the ducts connecting the two units may suit convenience.

TABLE III

Volume Modulus of Elasticity

Substance	Temperature, degrees Fahr.	Volume modulus, pounds per square inch	Absolute viscostly poises
Water	60	$0.32 - 0.39 \times 10^6$	0.01
Fixed Oils			
Castor	104	$0.28 - 0.38 \times 10^6$	1.820
Trotter	104	$0.26 - 0.33 \times 10^6$	0.344
Rape seed	104	$0.26 - 0.34 \times 10^6$	0.375
Sperm	104	$0.24 - 0.32 \times 10^6$	0.154
Mineral Oils			
Oil *A*	104	$0.30 - 0.37 \times 10^6$	1.770
Oil *B*	104	$0.28 - 0.34 \times 10^6$	0.495
Oil *C*	104	$0.28 - 0.35 \times 10^6$	1.415
Oil *D*	104	$0.28 - 0.35 \times 10^6$	0.470
Oil *E*	104	$0.28 - 0.25 \times 10^6$	3.240

Oil A is an extra-heavy bodied bearing oil.
Oil B is a heavy-medium bodied automobile oil.
Oil C is a heavy-bodied automobile oil.
Oil D is a light-bodied general purpose oil.
Oil E is a very heavy-bodied compounded steam cylinder oil.

Note: A compounded oil is a mineral oil containing a small percentage of fixed oil.

Actually if the size of the pump and motor units is to be kept within reason with regard to cost, space and appearance, it is essential to use reasonably high pressures. This necessity exaggerates the effect of compressibility and for practical purposes makes a fallacy of the old saw, "liquids are practically incompressible."

Any multicylinder hydraulic pump may be replaced for purpose of demonstration by a simple plunger moving in an endless cylinder at constant velocity. Fig. 2 may be used as an example.

At slightly above zero pressure infinitely slow movement of plunger *a* will be followed by ex-

actly equivalent movement of b transmitted by the fluid contained between a and b. If tangible resistance is opposed to the movement of b pressure must be built up on the fluid by force applied to a. This implies work and to effect work both force and movement of a are required before it is potentially able to overcome b.

Assuming that the plunger and duct areas are uniformly one inch square and that the resistance opposing b is 1000 pounds, a then will be required to build up a fluid pressure of slightly over 1000 pounds to set b in motion. Let us assume further that the distance x is six feet or 72 inches. a will be required to move a distance

$$\frac{1000}{14.7} \times \frac{53.4}{1{,}000{,}000} \times 72 = 0.26 \text{ inches}$$

before motion of b starts if fuel oil is the hydraulic medium.

If the resistance at b is the result of its motion as in feeding a drill into work the pressure will build up to full feed thrust only after the pump element has advanced 0.26 inches. As the drill passes through the work the ram will be advanced 0.26 inches by fluid expansion alone.

If the pump and motor elements were ten times as great in area and the fluid pressure one-tenth as much the lag and bursting through of the drill would be reduced in proportion to the pressure.

Gradual acceleration of work also is accomplished best by gradual admission through the

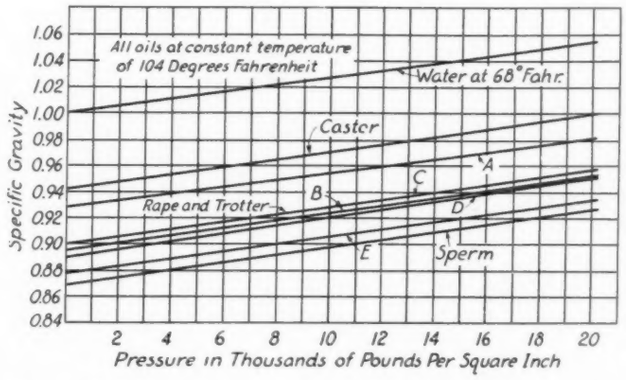

Fig. 4—Specific gravity of liquids increases with pressure

control valve rather than through fluid elasticity which in machines that "cut out" at the end of their traverse always causes undesirable acceleration when least desired. Feed rates may be controlled by throttling the discharge of the opposed or returning cylinders. Ingenious commercial valves are available for this purpose.

Most evils resulting from compressibility in hydraulic systems are due to large clearances in pumps and hydraulic cylinders and large volumes of fluid in piping. While the work of compression adds only a small area to the work diagram of any single pump cycle of unit discharge volume it may add a great deal to the work of a press cycle and according to Walter Ernst (see bibliography), to the time required to complete this cycle. If the volume of fluid contained in the ducts and in the hydraulic press cylinder equals, for example, fifty times the volumetric displacement of the ram which may be working on a short stroke job while considerably extended from the cylinder, compressibility will require $218 \times 0.000{,}048 \times 50 = 0.5$ times or ½ the time and pump work required for the actual press work if fuel oil is used as a medium at a pressure of 3200 pounds or 218 atmospheres.

Keenan has shown that more than 7500 foot pounds of energy are required to compress a pound of water from atmospheric pressure and displace it against a head of 3200 pounds per square inch. And, when it is realized that this 7500 foot pounds of energy may originate from a prime mover where approximately 300,000 foot pounds of fuel energy are required to produce it, it is evident that the work of compression should not be ignored.

Harmonic Oscillations Developed

Comparatively frictionless hydraulic apparatus develops harmonic oscillations of the motor plunger and load on the elastic transmission medium in definite and calculable frequencies. The friction of machine platens and carriages on their sparsely lubricated ways is effective in damping this vibration but advance by steps due to correlation between compressibility and the friction of rest and that of motion is always possible if the system is too elastic.

This action may be illustrated by dragging a weight across a surface plate with a light spring. It is quite impossible to make the weight move at uniform velocity.

This latter consideration calls for a minimum of liquid in the working part of the system, therefore selection of the most desirable operating pressure may call for first class engineering judgment as it involves so many factors of both mechanical and economic nature.

Bibliography

Love, *Encyclopedia Britannica* (Eleventh Edition).

Smithsonian Physical Tables. Sixth Revised Edition. Table 56.

Amagat, *Ann. chim. phys.* (6) 29, 1893.

Kaye and Laby, *Physical and Chemical Constants*, 1911.

Alexander, "Airless Injection of Fuels," *Transactions Institute of Marine Engineers*, London, vol. 39. p. 366. 1927.

Bartoli, *Rendus Lomb.* (2) 28, 29, 1896.

Quincke, *Wied. Ann.* 19, p. 401, 1883.

Keenan, *Mechanical Engineering*, Feb. 1931.

Ernst, "Influence of Oil Compressibility on Speed Characteristics of Hydraulic High Speed Presses," Paper presented at Buffalo meeting, American Society of Mechanical Engineers, Oct. 3, 1932.

Hyde, "On the Viscosities and Compressibilities of Liquids at High Pressures," *Proceedings of the Royal Society of London.* vol. 97. 1920.

Heck, "Compression of Liquid Water," *Power.* Sept. 22. 1931.

Know Your Shop!

Digest of Papers Pertinent to Design Presented During the Metal Congress

CORRELATION of design and production is a significant factor in modern engineering. Increased flexibility and versatility in machine tools are required to meet the designer's needs. These expressions of opinion were given at the production meeting sponsored by the Society of Automotive Engineers during the recent National Metal congress held at Buffalo. The former statement was made by Alex Taub, Chevrolet Motor Co., and the latter by L. F. Maurer, Pierce Arrow Motor Car Co. Papers delivered by both engineers curiously enough, covered similar phases of design and production activity.

Advancement in engineering standards has created, according to Mr. Taub, the need for increased production ingenuity. Refinements in design are useless unless the machine shop can hold dimensions accurately; we must have rugged accuracy without fixed centers. The fact has become increasingly evident that the engineer should know his shop and shop man in order to temper his suggestions to prevailing conditions. On the other hand the shop man, by his intimacy with engineering test results, can see the parts he is producing in the light of their functioning.

Hydraulics, the application of which has characterized one of the more recent trends in design of machinery, provided the background for a discussion on the influence of oil compressibility on speed characteristics of hydraulic high speed presses. The data was presented by Walter Ernst, Hydraulic Press Mfg. Co., Mt. Gilead, O., at the machine shop practice division of the American Society of Mechanical Engineers.

Lists Advantages of Hydraulics

Some of the advantages of hydraulics stressed by the speaker include accuracy of control of forces as to magnitude, direction and speed; smooth action of the driven apparatus; flexibility and versatility of the machines on which the hydraulic systems are applied; economy in design, high efficiency and overload protection.

Discussing technique of size control in precision grinding operations, R. E. W. Harrison, Cincinnati, claimed it is an unfortunate fact that some designing engineers are not sufficiently informed regarding the accuracy and producing possibilities of new machine tools; hence the frequent assignment of limits which, if adhered to, would inflate the costs and also result in the limits being taken by the shops as a guide only and ignored, with consequent increase in the cost of assembly and occasional faulty functioning.

The design angle on grinding problems is of paramount importance, Mr. Harrison said. As an example he pointed to an article of general household use that was designed with over twenty component parts calling for limits of accuracy within a total tolerance of two-tenths of one thousandth of an inch. The experimental models were made in a tool room where no accurate records of the costs were obtained. Moreover, there was undue optimism regarding the capabilities of the machine tool equipment to produce the components rapidly to the prescribed limits of accuracy and at a low cost. A vast quantity of work was put into progress, but when it was in its final stages of manufacture the real difficulties arose.

Redesign Overcomes Difficulty

As is usual in a manufacturing scheme of this kind the inspection department reported directly to the management and the inspectors demanded from the production lines, limits of accuracy in accordance with the figures set down by the engineering department. The whole scheme reached a deadlock and the tangle was solved eventually only by a redesign of the major units. Proper functioning was obtained with two parts made to the fine tolerances and the remainder of the parts to commercial limits with a tolerance of 0.0005-inch on each piece.

Generally speaking engineers can be employed who are capable of designing mechanisms which will perform any reasonable function under almost any condition, but the genuine engineer is the man who can design equipment which will achieve the desired results, with the minimum number of parts, made to maximum tolerances.

Other societies and divisions participating in the metal congress were the iron and steel division of the American Society of Mechanical Engineers, American Society for Steel Treating, American Welding Society, American Institute of Mining and Metallurgical Engineers, Wire Association, and American Drop Forging institute. New products and equipment exhibited at the exposition reflected the efforts of manufacturers to meet the demands of lower costs, more efficient production and superior quality which have been imposed by the depression.

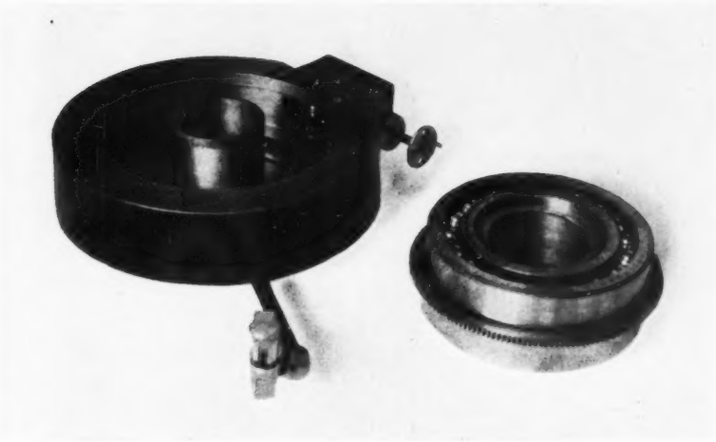

Fig. 1—Worm for driving bearing is coupled to a fractional horsepower motor which drives from the side

Reducing Friction in Antifriction Bearings

By Thomas Barish

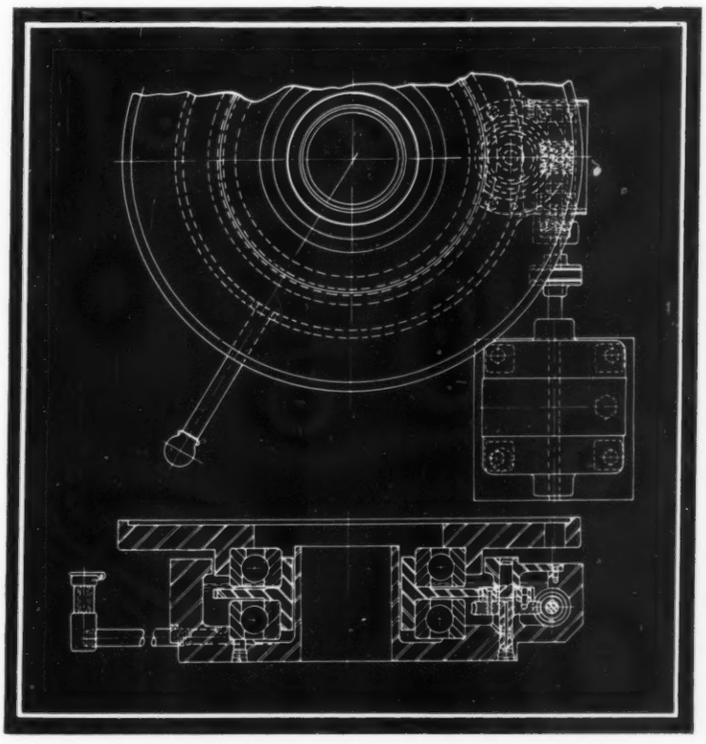

Fig. 2—Special arrangement of bearing used to overcome friction and provide accurate measurements on equipment

FEW designers realize that ball and roller bearings have a definite and measurable frictional resistance even though they are called antifriction bearings. This frictional resistance is small compared to that of the usual sliding or plain bearing, but nevertheless it does exist and has some clearly defined characteristics. In the first place, there is little variation over wide ranges of speed and load for any one bearing. On the other hand, there are considerable changes among the bearing types. The common ball thrust bearings have less friction than radial ball bearings because of their internal design.

Furthermore, any particular type of antifriction bearing can have its frictional resistance reduced by modifying the design of the parts. In a ball bearing this usually entails a loss in capacity; in a roller bearing, closer tolerances.

Occasionally a machine design problem arises calling for a study of the small friction of ball or roller bearings. Usually this is a heat problem, although heat is caused most often by other things—excessive preloads, excessive lubrication, off-square conditions or rubbing parts.

Ball bearing friction now is being utilized to measure preloads on machine tool spindles. The coefficient of friction of the present day ball bearing is approximately 1/600 under

thrust load. A preload can be determined by measuring the drag or friction; that is, how much weight at any radius is necessary to keep the spindle turning once it is started. This factor may be expressed as

$$Preload = \frac{inch\ pounds\ drag}{pitch\ radius\ of\ bearings} \times 600$$

Usually this is divided by two because the same load is applied on each of the two opposed bearings.

Described in the following is a special machine problem which required an unusual arrangement to eliminate the effect of the small

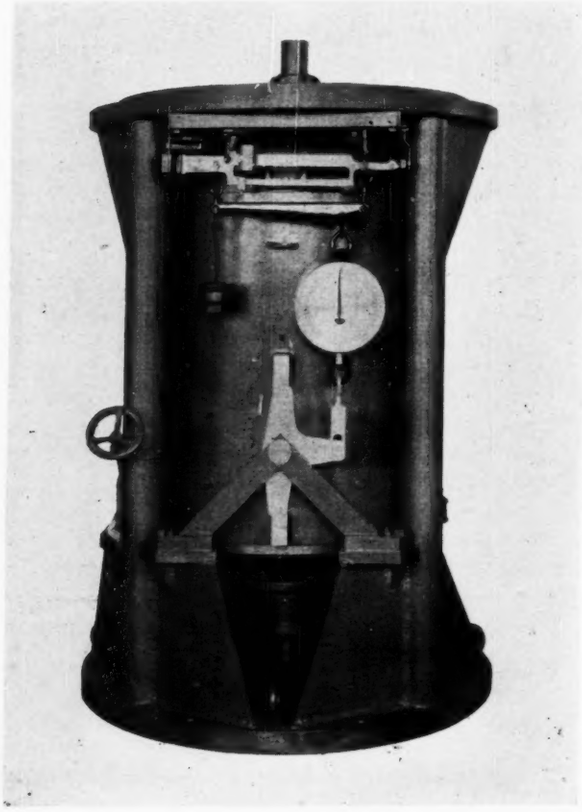

Fig. 3—Extreme sensitivity was required for measuring slight change in efficiency with this dynamometer used for testing water wheel design

but definite ball bearing friction. A large dynamometer (300 horsepower 1325—2500 revolutions per minute) was set up vertically for special development work on a new hydroelectric plant at the Holtwood, Pa., experimental station of the Pennsylvania Water and Power Co. The machine was intended for determining the effect of small variations in the design of the water wheel and water passages. Hence, extremely fine sensitivity was required for measuring slight changes in efficiency.

The dynamometer was constructed by setting a standard horizontal unit up on end, Fig. 3. The usual pivot bearings, which carried the entire unit and permitted it to oscillate freely so as to measure the absorbed torque, originally were ball bearings of a type not suited to carry the weight of the whole machine, about 9000 pounds, as a thrust load. The lower radial pivot bearing was omitted and in its place inserted a standard Gurney angular-contact type bearing, 5.113 inside diameter, to serve both for carrying the large thrust load and locating the frame radially.

Sensitivity Proved Insufficient

Immediately after the unit was installed its sensitivity was found to be insufficient. This was indicated first by the fact that points intended to be on a smooth curve were spread over a considerable band. Bearing friction was blamed and an attempt made to measure the error. Zero readings were taken with the dynamometer rotating without load, first in one direction and then in the other. The differential was about 6 pounds total at 21-inch radius, or 63 inch-pounds for one direction. This amounted to 1.2 per cent of the maximum scale reading of 500 pounds.

Checking up with the bearing manufacturer indicated that about 60 inch-pounds frictional drag was to be expected under the given load for this particular bearing or any other similar bearing. The problem was then to reduce thrust bearing friction or eliminate it, since brush resistance or windage losses apparently were already small.

A few tests showed that the bearing friction could be reduced by minimizing the size of the contact area between the ball and the race. Various parts of the contact surface tend to travel at slightly different speeds, thus producing an internal friction that varies naturally with the size of the contact area.

Flatter race curvatures with less intimate contact between ball and race reduce the area and the friction: For example, the usual ball thrust bearing, having rather flat race curvatures, will show a lower friction, particularly at light loads and low speeds. Note, however, that the capacity per ball falls rapidly as the race curvature is flattened.

Friction Less at Low Loads

The tests also indicated a reduced friction at low loads. Under heavy loads the size of the contact area between ball and race increases materially, and the friction with it. This change was much more noticeable in the thrust type ball bearings.

At the conclusion of the foregoing tests a special Gurney bearing was made with flatter curvatures and maximum possible number of balls. A bearing with the same bore and lesser outside diameter permitted the use of a much larger

(*Concluded on Page* 64)

New Books Reflect Progress

Dynamics, Photoelectricity, and Design Details Are Covered in New Volumes

Dynamics of Engine and Shaft, *by Ralph E. Root; published by John Wiley & Sons Inc., New York; available through* MACHINE DESIGN *for* $3.00 *plus* 15 *cents postage.*

Prepared primarily as a text book, the material presented in this volume was compiled in such a manner as to be intelligible to the reader who may not have a full working knowledge of the field which the volume covers. Prof. Root has introduced methods for evaluating the forces in a reciprocating engine, to trace their effects in turning moment on the shaft and in bearing pressures, and by emphasis on the periodic character of forces, to disclose their significance.

Treatment of torsional and transverse vibrations of elastic systems and a discussion of critical speeds are included. The first seven chapters deal with balance, turning moment and bearing pressures, while the concluding three cover vibrations.

□ □ □

Photoelectric Phenomena, *by Arthur L. Hughes and Lee A. DuBridge; published by McGraw-Hill Book Co. Inc., New York; available through* MACHINE DESIGN *for* $5.00 *plus* 15 *cents postage.*

In a critical survey of the broad field of photoelectricity Messers. Hughes and DuBridge present a thorough discussion of the three major branches: Surface photoelectric effects, volume photoelectric effects and photovoltaic effects. Fundamental laws and principles of each are summarized fully, supplemented by an explanation of their experimental bases, theoretical significance and practical application.

Special features include a comprehensive review of recent developments in photoelectric effect in metals, a detailed outline of modern experimental methods employed in research and measurements, and a discussion of the design, construction and characteristics of modern alkali-metal photoelectric cells. With the rapid advance in the application of the "electric eye" in design of machinery this book has a definite place in the engineer's library. It is timely in appearance and should prove invaluable as a reference work and guide.

The text is profusely illustrated with diagrams and curves and is interspersed with tables of important and useful data. It is modern in viewpoint throughout.

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Business Machines, *by Perley Morse; published by Longmans, Green & Co., New York, and available through* MACHINE DESIGN *for* $3.75 *plus* 15 *cents postage.*

Indispensability of the business machine in the everyday transactions of commerce, finance and industry is established and engineers are being called upon to develop even further these labor-saving devices. For the technician engaged in this line of endeavor, the new volume entitled *Business Machines* will provide information that will serve to strengthen his background.

While the author is not an engineer, he has come into contact with practically all types of this class of equipment through his long experience as a certified public accountant. Because the book is a history of the development of the business machine it warrants consideration by the engineer. Circumstances surrounding the conception of various types of units are described, even to the point of difficulties which had to be overcome in design.

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American Machinists' Handbook, *by Fred H. Colvin and Frank A. Stanley; published by McGraw-Hill Book Co., New York, and available through* MACHINE DESIGN *for* $4 *plus* 15 *cents postage.*

Data in the new fifth edition of this handbook has been fully revised and supplemented to provide a complete and concise reference for those engaged in mechanical work. In the five years since it last was brought up to date many changes have come about in shop practice, and the editors in this fifth edition have carefully studied these developments, compiling the new data and tabulating the practical suggestions of handbook users for inclusion.

Augmenting the information directed to machinists, the volume incorporates such information as data on screw threads, horespower, belts and shafting, measuring and fitting, brazing, soldering and welding, bolts, nuts, screws, etc.

Simplifying Parts Production by Die Casting

By Louis H. Morin

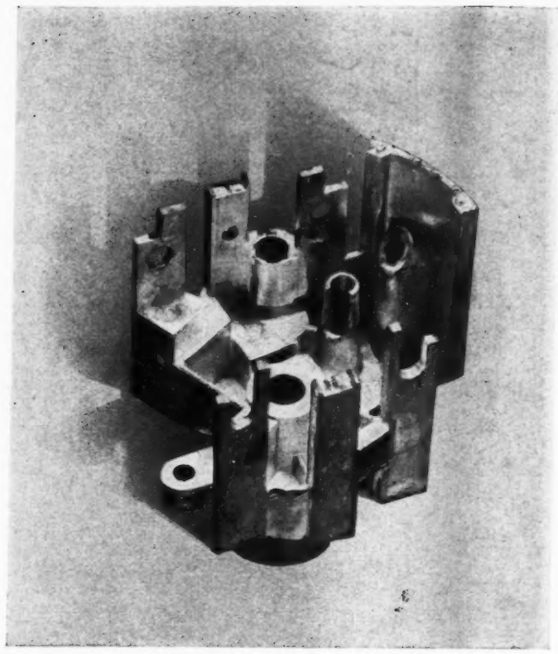


Fig. 1—Extreme accuracy and uniformity is required in this complicated main frame

DIE CASTING is well known for its ability to eliminate machining operations, yet there are other advantages in this process that are of equal value to the designer. Mr. Morin, chief engineer, Doehler Die Casting Co., outlines some of these qualities in the accompanying article based on a paper presented at the Mechanical Engineers' recent meeting at Buffalo.

FUNDAMENTAL factors of quality in die castings include strength, accuracy, and uniformity. Strength is obtained by the correct designing of the part, by choice of the proper alloy and use of only the best raw materials, by alloying under the strict supervision of chemists and metallurgists, by protecting against segregation in the process of casting, by producing a casting that is closely grained, and by eliminating casting defects. All these points must be controlled carefully for strength in a casting.

Accuracy is assured by the proper calculation of shrinkages, by the accurate construction of the die, by temperature control of the die as well as of the alloy, and by a system of continuous checking by gages or templets for the detection of inaccuracies.

Uniform castings are produced by absolute uniformity of the alloys, by temperature control, by maintaining uniform conditions during the casting process, by weighing each casting for the detection of any variation, and by extreme care in the process of cleaning. As uniformity makes for interchangeability of parts, the points enumerated must be adhered to rigidly.

A fundamental advantage of using die castings instead of machined parts is in eliminating machining operations. This holds true irrespective of the metal or alloy cast. Besides saving machining operations employment of die castings effects other savings and also opens new fields to the designer. The following examples are taken from the author's experience, and have been modified from the ac-

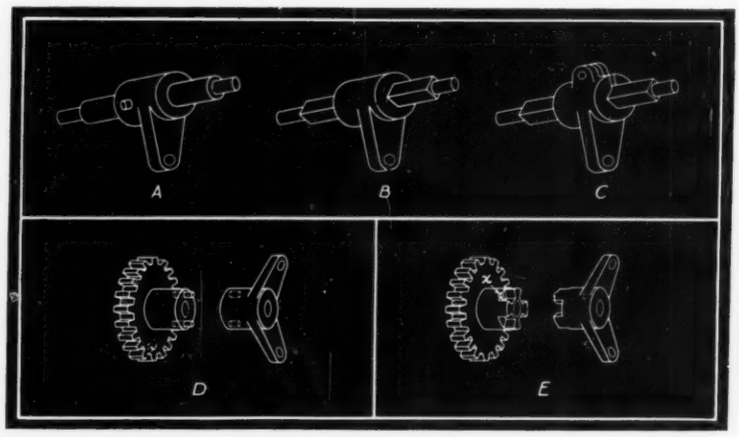


Fig. 2—Odd shaped holes or pins are as easily incorporated in die castings as round ones and often prove advantageous

tual examples to illustrate composite or general cases.

Fig. 2*A* shows a common and accepted method of mounting a lever to a shaft. The lever originally was held on the shaft by a taper pin and represents a distinct economy in comparison with the method shown in Fig. 2*B*. It costs no more to cast a square hole than a round one and the method shown at *B* serves a greater advantage at no greater cost. This fact may lead designers to consider the advantage of odd-shaped holes by the use of die castings. A clamp-hub method of fastening such as shown in Fig. 2*C* often is desirable, but is not used because it is considered comparatively expensive. As a die casting, however, this construction adds little to the cost as compared with the methods shown in Figs. 2*A* and *B*.

Correct Assembly Assured

Fig. 2*D* shows a proposed method of joining the hub of the gear to the hub of the double lever. End drive pins were to be driven into the hub of the gear and mating holes drilled in the lever to meet them and to act as a driving connection. For a machined casting the method as shown in Fig. 2*D* would be cheaper than that shown in Fig. 2*E*. As a matter of fact, *E* is cheaper than *D*

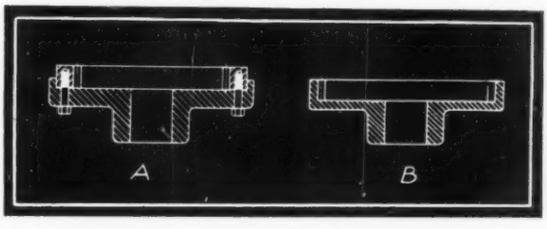


Fig. 3—Difficult machining required in cutting internal teeth can be eliminated by casting the teeth straight up against the shoulder

to produce as a die casting and is admittedly a far better piece of construction. The additional key at *x*, Fig. 2*E*, insures assembly only one way.

Machine construction frequently calls for the riveting of a part to a die casting. In a number of cases riveting studs can be cast directly into the piece at practically no extra cost and a final saving effected. Besides this, a head might not harmonize with the design of a finished surface, and by die casting the rivet in one piece with the casting the head does not show.

Internal gears are often more desirable than spur gears but they are used less frequently due to the prevailing impression in machine-cut gear practice that internal gears cost more to cut and mount than ordinary spur gears of the same size. While there is a wide differential under the usual machining methods this is not true when the gears are die cast. In Fig. 3*A* is shown the usual construction of an internal gear with its mounting by fastening the internal gear to the hub by bolts or rivets. This calls for considerable machining and is one deterring factor in a designer's mind that discourages its use.

The same problem viewed from a die casting standpoint is illustrated in Fig. 3*B*. When cast as one part the cost will be less than the built-up unit shown in Fig. 3*A* due to the saving of machining labor. Of particular interest is the fact that the teeth are cast straight up against the

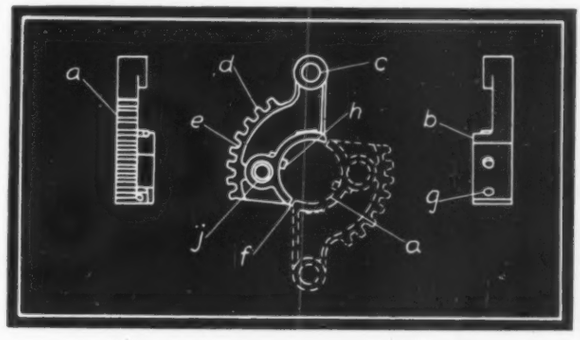


Fig. 4—Cost of die casting this drive is about one-half of the cost for machining an ordinary cast unit

shoulder insuring a stronger tooth construction. A smooth exterior also is obtained.

The following example shows an actual comparative cost analysis between die castings and machined castings. The cost analysis for the machined casting was submitted by a reputable machine shop, and the die casting cost analysis is taken from an actual example. The cost analysis of the drive segment, Fig. 4 for 1000 machined castings including all patterns, tools and material is

	Rate	Per piece
Pattern	$10.00	$0.01
Material (weight of casting 1 lb.)	0.07 lb	0.07
a—Operation: Potter & Johnson machine, finish face and bore hole 4 min.	1.30 hr	0.045
b—Operation: Grind hub, 1 min.	3.00 hr	0.025
c—Operation: Drilling large holes.....		
4 min.	1.30 hr	0.045
Drilling Fixtures	25.00	0.025
d—Operation: Mill radius, 3 min.	1.50 hr	0.04
Milling fixtures	20.00	0.02
e—Operation: Cutting teeth, 6 min.	1.30 hr	0.065
Mandrel for cutting teeth	25.00	0.025
f—Operation: Splitting, 2 min.	1.50 hr	0.025
g—Operation: Drilling large holes.....		
3 min.	1.30 hr	0.07
h—Operation: Make and assemble pin, 1 min.	1.30 hr	0.02
j—Operation: Bushing, 1 min.	1.30 hr	0.02
Total cost for one drive segment machined castings		$0.505

Note: The cost of bushing is eliminated because this part is used in both analyses.

As a die casting the drive segment and an operating cam were made in the same die. The cost analysis of the drive segment for 1000 die cast-

Casting Limits of Typical Die Casting Alloys

	Tin	Lead	Zinc	Alum.	Copper
Max. weight of casting, lb.	10	15	24	10	3
Min. wall thickness, large casting, in.	1/16	1/16	1/16	0.085	0.125
Min. wall thickness, small casting, in.	1/32*	1/32	0.035	0.050	0.050
Variation from drawing dimensions per inch of diameter or length, in.	0.001*	0.001*	0.001*	0.002*	0.003*
Cast threads, min. no. per in., external	32	32	24	20	10
Cast threads, min. no. per in., internal	32**	32**	24**	none	none
Cast holes, min. diameter, in.	0.031*	0.031	0.031	3/32	3/16
Draft per inch of length or meter of cores, in.	none	none	0.003	0.015	0.020
Draft per inch of length or diameter of side walls, in.	0.0005	0.0005	0.005	0.010	0.020

*Depends on conditions. **Where cheaper than tapping.

ings, including die and tools, is given in the following tabulation:

Item	Per Piece
Die and tools ($220.00)	$0.22
Cost of casting	0.12
Total cost of one die casting	$0.34

The comparison per casting is

Machined Casting	Die Casting	Saving
$0.505	$0.34	$0.165

On a reorder the comparison per casting becomes

Machined Casting	Die Casting	Saving
$0.425	$0.12	$0.305

The cost of the die being charged to the first order accounts for the greater saving shown on consequent orders. It is apparent that it would be economical to make these particular castings

Fig. 5—Lugs, ribs and holes are permissible in design as illustrated by this gear case, about 14 inches in overall length

in a quantity as small as 500 and still show a saving, plus the fact that the dies always would be available for future orders with increased savings.

Aside from a mechanical advantage other important factors that die castings offer are appearance, style, and designs of unlimited quantity. An example of this is indicated in Fig. 6, at the left, which shows a common knob. Knob *p* is made of two screw machine pieces securely fastened together; the rod *k* is driven into the stem *m* and the whole piece chrome plated. It is obvious that strictly conventional lines were employed in making this piece, and considerable "parental" influence was transmitted in specifying the piece as a die casting because from a standpoint of appearance the exact shape of the piece as originally made was followed.

Certain milling operations as dicated at *n* proved this piece to be more economical as a die casting but the factor overlooked by the manufacturer when ordering the piece as a casting was the improved appearance that could be obtained as indicated in the redesigned knob *v*. The new design has the

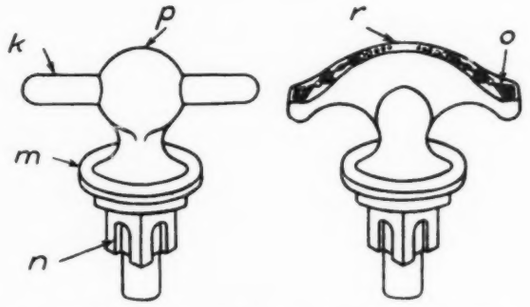


Fig. 6—Detailed decoration can be added to parts without minimizing their utility value

same utility value but it makes a great difference in the appearance of the unit to which it is attached. Notice the engraving on the face of the new handle as shown at *o*.

Details Should Be Perfect

In connection with this form of fine detail a prominent artist expressed an interesting opinion. Asked why he had incorporated minute detail in an automobile radiator cap that could hardly be seen a yard away, he replied that his object was psychological. Upon close inspection the fine engraving and ornamentation would register in the prospective buyer's mind an impression of thoroughness and attention to detail which in turn would reflect favorably upon the product. Fine engraving and intricate detail can be incorporated in die casting and the only extra cost involved in the die, while the finished part is greatly improved.

Die castings should be designed to take full advantage of saving every possible machining operation. They should be made to render their full utility value, and the artistic or appearance angle should not be overlooked.

Are Management's Criticisms of Engineers Fully Justified?

By John Stedfast

"Engineering department often is censured due to practice of 'passing the buck'"

OPEN publication of charges released by both engineering departments and managers has done a great deal toward creating better mutual understanding. The author, who has had twenty years experience as an engineer during part of which time he has been chief engineer, presents the practical viewpoint so often submerged.

IN EARLIER issues of MACHINE DESIGN opinions of management and of other department heads were given regarding the work of the engineering department. The following is written in answer to some of the comments contained in the articles in the hope that managers who read it may be able more thoroughly to understand the viewpoint of the engineer.

The engineering department has relations with the sales, manufacturing, inspection, service, purchasing and cost departments, and with the management. When the management is intelligent and progressive no difficulties arise between the several departments that cannot be settled quickly and amicably, but when the management is inclined to be dictatorial or lacks a grasp of the proper relations of the different departments there is bound to be difficulty.

It goes without saying that there must be close co-operation between all departments if each is to function at its best. If the product has to be engineered the salesmen cannot be mere peddlers, but must be engineers who have sufficient acquaintance with the engineering department, the shop and the service department to have an adequate background upon which they can base their sales work. In like manner, if many different kinds of material or parts must be purchased, the purchasing department must be able at least to speak the same language as the engineering, manufacturing and inspection departments. The engineering department must be familiar with the troubles encountered by the service department and also must understand thoroughly the plans and difficulties of the sales staff. Engineers frequently should be invited to assist salesmen in their work in order that they may obtain complete knowledge of the desires and prejudices of customers.

All of these facts should be appreciated by the several departments concerned. Without this there will be no co-operation. The principal function of the management is to increase the spheres of activity of the several departments and to secure the utmost degree of co-ordination.

"The management" is an elastic term. In gen-

eral, it means that man or group of men who are in supreme authority in an industrial enterprise. Hereafter the term "manager" will be used as meaning the executive officer who represents the owners and directors and who has the authority requisite to make final decisions on all matters, subject only to the approval of the directors.

The two greatest evils which usually confront the manager are "shop politics" and "buck passing."

Petty Jealousies Ruin Co-operation

Shop politics is one of the curses of modern industry. It is the striving of executives to secure undeserved pay, prestige or power, to magnify their work unduly, to find places for their favorites or to undermine the positions of their fellow workers. In general, such conditions naturally arise within each separate department, but between the several departments they have little effect unless the manager is weak. If the chief engineer can keep his department free from shop politics he will have little trouble from this source.

However, buck passing may make him trouble of much the same kind. The sales department falls short of its quota and for an alibi claims that improved designs would permit them to do much better; or perhaps they pass the buck to the shop and claim that the manufacturing costs are so great that they cannot meet competition and sell at a profit. Then the shop passes the buck and claims that the design cannot be manufactured efficiently. In every case the matter should be settled not by squabbles between the several departments but by wise and thoughtful action on the part of the manager.

To the manager who is not acquainted with the evils of shop politics and buck passing, or who fails to recognize the symptoms when a case appears, the engineering department often may seem to be at fault. It has been my experience that about fifty per cent of the engineer's troubles which arise outside of his department are due to the two causes mentioned. In many cases the manager fails to see the true reason for the difficulty and accordingly blames the engineer for unsatisfactory or inefficient work. Because of its peculiar place in the organization the engineering department cannot pass the buck to anyone else and cannot create much trouble by underhanded politics. Consequently, unless the manager is wise and open-minded, the engineering department suffers unduly from political activities and buck passing by other departments.

It frequently is alleged against engineers that they are not "human." When a salesman makes this assertion, he means that the engineer does not capitalize his personality for the purpose of conducting his work. Many engineers have a negative personality, while others are pleasant or even magnetic. However, engineering is done with a slide rule and T-square rather than with showmanship. Accordingly the engineer in his relations with other departments and the customer is apt to be a serious minded person who delivers his opinions without undue warmth and without regard to anything except the practical facts as he sees and interprets them.

SHOP politics is one of the curses of modern industry. It includes the striving of executives to secure undeserved pay, prestige or power, to magnify their work unduly, to find places for their favorites or to undermine the position of their fellow workers.

There is a second relationship which makes the engineer, in the opinion of many people, "not human." He does not concern himself primarily with people. He considers materials, movements and forces. He deals with facts, not with emotions, and the minute that he ceases to deal with facts and allows his emotions or desires to influence his judgment he loses all value as an engineer.

The engineer has no troubles which come from other departments except as they come through the management. No other department can dictate to him what his work shall be. Automatically he dictates to the manufacturing and purchasing departments, and he may cause them a great deal of trouble, but no one except the manager can tell him what he must do.

Unless the engineer is incompetent his troubles usually are due to faults of the management, for it is beyond question that it is easier to design,

"If engineer allows his emotions to influence him he loses all value as an engineer"

make and sell goods than it is to manage an industrial organization. Management, however, often is done by inspiration. The manager "has a hunch" that a certain product will go over in a big way, and then it becomes the duty of the engineers to design it, of the shop to make it and of the salesmen to sell it. If the manager is satisfied with the design and the product fails to sell, the sales department is the goat. If the management is not satisfied with the design because the idea is impractical or because it may be impossible to reconcile conflicting technical demands, the engineer is the goat.

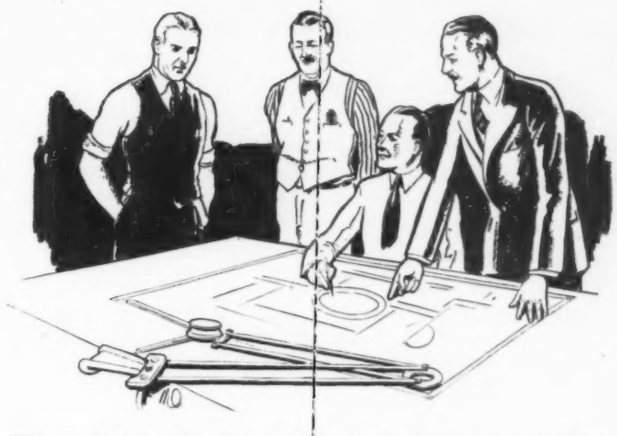
The engineer frequently is called upon to attempt the impossible. Usually this takes the form of being asked to produce a design superior in quality, material and workmanship to competing designs which will sell for a lower price.

THE principal defect of the engineer is that he is not a good salesman within his own company. Furthermore, when he goes outside to help the sales department there is only one kind of customer with whom he is successful and that is the customer who buys with enlightened self-interest in mind.

Many an engineer has been requested by the management to design some particular improvement when he knows in advance that the improvement will cost so much that it cannot be sold. The management, seeing only the desirability of the improvement, is inclined to discount his statements and recommendations and tell him to go ahead with the design. After much labor the design is produced. It is an excellent design mechanically, yet it is not a success. It costs too much or is in advance of its time and is not required in such quantities that it can be manufactured by special processes at a low price. Is the engineer or the management at fault?

Outlines Design Procedure

A second difficulty which the engineer encounters in his relations with the management is the demand that he produce a design in insufficient time. Common sense dictates that a number of designs be prepared and that they each be considered carefully with reference to sales appeal, the real needs of the customer (which often is a radically different matter from sales appeal), cost of manufacturing, service difculties and patent infringements. After such preliminary work is done a period of discussion should ensue followed by a period in which the details are refined. When the task is undertaken in this way a successful design is bound to be



"Foremen drop into the engineering department and obtain many helpful suggestions"

produced. However, directors and managers are frequently impatient, demanding that the work be done immediately. As a result many mistakes are made both in design and construction and the final product either is pronounced unsatisfactory, or assumes satisfactory form weeks or months after the expected time.

Managerial indecision often hampers engineers. An engineer usually knows whether a design is satisfactory or unsatisfactory. If it is unsatisfactory he knows whether it should be rejected entirely or altered and improved. When he has arrived at the point where he is satisfied with his design and has presented it to the management, he should be able to expect that a decision will be forthcoming upon which he can proceed. This often is not available.

Experimental Investigation Needed

The attitude of many managers, especially non-technical managers without an adequate engineering background, toward the technical knowledge of the engineer is frequently amusing, but more often irritating. The engineer is expected to know a great many things which nobody knows, and which nobody can know without a great deal of experimental investigation. The engineer's opinion is taken without any question upon matters of which the management is totally ignorant and knows that it is totally ignorant. The engineer may be dubious himself about the soundness of his information and may point out that there are two schools of engineering thought with regard to the matter, and that at best he is giving an opinion, but his opinion is received with respect.

On the other hand the manager may have definite opinions of his own which have no basis in fact, and may dispute with the engineer about such elementary matters as the strength of a wire rope or the stiffness of a beam. A manager who has never run a machine in his life will settle arbitrarily on an incorrect location of controls on the basis of appearance in spite of the

fact that the engineer knows by experience that the design he proposes is correct from the standpoint of safety and convenience.

Another difficulty which the engineer has with the management is impatience while the engineer is seeking to refine and improve a design which he has reason to believe will be satisfactory. Many managers are the reverse of timid or hesitant; they make up their minds without rhyme or reason in the tick of a watch. A piece of apparatus gives trouble in the service depart-

"The engineer is not a good salesman"

ment but no one can tell why. The engineer institutes a study to find where the difficulty lies. He gives to the work such time as he can spare from other and even more pressing matters. After two or three days the manager wants to know why the difficulty has not been remedied. Since the engineer has not yet found the cause of the trouble the manager is apt to decree an entire change in design.

Interference on the part of the manager in the detailed administration of his work is a situation that the engineer in common with other department heads frequently encounters. This interference may come because of representation from other departments or because the manager feels the need of asserting himself. Those managers are most successful who leave the detailed administration of each department to the head of that department and confine their efforts to co-ordinating the work of the departments.

Advice Is Available

The engineering department cannot make available its services to those who will not have them. I have in mind a certain small company whose shop is in the hands of a hard-headed superintendent and a group of practical foremen. Two of these foremen have discovered that the engineering department may be a great help to them, that they can drop into the office and discuss their troubles and receive practical advice about phases of their work which they do not understand. The other foremen do not avail themselves of this opportunity but prefer to work by rule of thumb. One department thus gets a full measure of service while another gets nothing.

The principal defect of the engineer is that he is not a good salesman within his own company. When he goes outside to help the sales department there is only one kind of customer with whom he is successful and that is the customer who buys with enlightened self-interest in mind. With the customer who is arrogantly ignorant, with the one who knows much that is not so or whose only thought is of price concessions the engineer is never successful. Fortunately, the type of customer who gives intelligent consideration to his own best interests is in the great majority, and with such customers an engineer of reasonably good personality is a successful salesman. Within his own company, however, the engineer does not regard himself as a salesman. He feels that it is the business of the management and of his fellow workers to listen to his suggestions and to consider them on their merits. If he says "it can't be done" when someone makes a suggestion, it is usually because he knows that it cannot be done in the manner suggested or that the proposal embodies obvious inconsistencies. The engineer is always open-minded toward changes which are sound from an engineering standpoint, but he is anything but open-minded toward changes for the mere sake of change.

Suggestions Aid Engineers

One of the best managers with whom the writer has ever come in contact was a lawyer. He frankly admitted that he knew nothing about the work of the several departments which were under his control. But he was a man of common sense, vision and tact, who was able to keep each department within its own proper sphere of activity, and at the same time to create a spirit of co-operation and helpfulness between the several departments. To the engineers he never offered engineering advice, but he offered many helpful suggestions as to the best organization of their department and its relations to other departments. He offered no criticism of their work but did invite outside engineers to offer such criticism, not to him, but to the engineers who worked under him. He sometimes, but not often, changed his policy and ordered corresponding changes in the engineering work. His whole attitude was one of helpfulness.

Faults of management cannot, of course, always be blamed on the individual manager. He often is hampered by his board of directors, by market conditions or financial limitations. He must be jack of all trades and master of none, and he has little of precedent, theory, or formula to guide him.

Complete Redesign Required for Welded Construction

By D. L. Pellett

CONSIDERABLE attention to stress distribution and stress magnitudes is required of the welding designers since he cannot design upon experience gained from the construction of cast machines. Stress determinations in weldings often require new methods of analysis and original angles of approach.

Pebble mills are among the many machines that have been redesigned for fabrication by welding with a resultant lowering in manufacturing costs and the production of better equipment. Since these mills are typical of a large class of similar machines it seems worth while to consider the procedure that was followed in the design.

In the past it has been general practice to build pebble mills, tumbling mills and similar structures with cast heads and riveted shells. In some cases the heads were secured to the shell with the aid of an adapter ring which, in turn, was riveted to the shell and bolted to the head. This type of construction necessitated the use of large and expensive patterns and drill jigs. Fig. 3, top, shows the details of such a mill.

IN the October issue Robert E. Kinkead outlined the importance of proper stress determination in welding design and pointed out various considerations that should be taken into account in this form of construction. An actual example of redesign and analyzation of stresses for fabrication by welding in a pebble mill is given in the accompanying article. Mr. Pellett was a prize winner in the recent Lincoln contest.

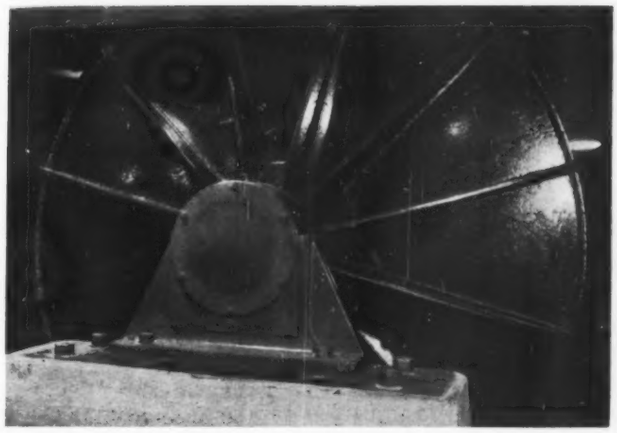


Fig. 1—Twelve radial ribs resist bending moment imposed on the head by journal reaction

Fig. 3, below, is the welded unit that replaced the old design. The outer shell is a ½-inch steel plate, rolled to shape and welded at a butt joint. The head consists of a ½-inch, circular steel plate with a steel journal casting welded to the center of the head. This design was chosen in preference to a dished end plate, with a flat strengthening diaphragm, by employment of which it might have been possible to place the weld between end plate and shell plate at a point of lower stress. Satisfactory operation of the completed units over long periods has proved the present arrangement successful.

Drive Shaft Welded in Place

The casting on the driven head is bored for the drive shaft which is welded in place. Twelve radial ribs, each ¾-inch thick, resist the bending moment imposed upon the head by the journal reaction. This mill was designed for a total dead load of 70,000 pounds and a rotational speed of 16 revolutions per minute. The load includes the weight of the drum, a lining of silica brick, a quantity of quartz pebbles and the material being processed.

Surfaces of pebble mills are subject to severe corrosion. This condition makes it advisable to

keep the working stresses in the structure as low as possible. The writer has considered the head plate as carrying only torsional loads. The bending stresses in the shell plate are quite small, yet the corrosive conditions and fabrication re-

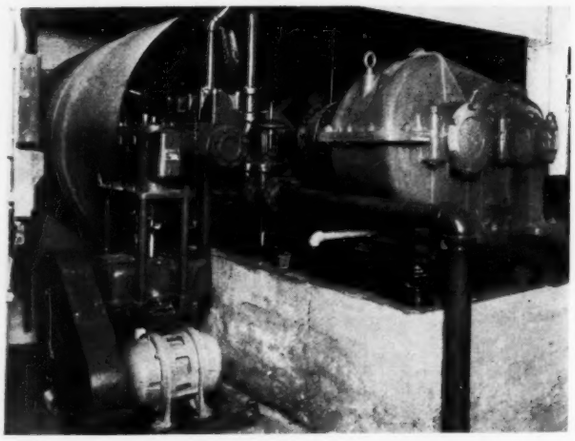


Fig. 2—Pebble mill is designed for a total dead load of 70,000 pounds and a maximum speed of 16 revolutions per minute

quirements would not permit a reduction in plate thickness.

The maximum working stress in the ribs was assumed to be 8000 pounds per square inch, this figure giving a factor of safety of four based on a fatigue limit of 32,000 for mild steel. Welds in tension, compression or bending were stressed to 5000 pounds per square inch, welds in shear were stressed to 4000 pounds.

A stress analysis of the head is complicated by the indeterminate nature of the structure. The bending forces acting at the outer ends of the twelve ribs are distributed according to some unknown relationship. This relationship cannot be determined with the static equilibrium equations of applied mechanics. In other words, the structure is statically indeterminate with twelve unknowns.

Number of Unknowns Reduced

However, it is fortunate that the head can be analyzed in a position symmetrical with the horizontal and vertical center lines of the machine. In this case the loads acting upon any four symmetrically placed ribs will be equal, thus reducing the number of unknowns from twelve to three. These three unknowns can be determined with the aid of Castigliano's theorem of "least work." This theorem states that, "the internal work done in any structure by the application of external forces will be the least possible, consistent with equilibrium." The following are the steps in the application of Castigliano's theorem.

Compute the work done in the structure by the application of external forces.

W = work stored in a beam

$$= \int \frac{M^2 dx}{2\,EI}$$

M = bending moment in a beam section x distance from the end of the beam

dx = increment of beam length

E = modulus of elasticity of the material in the beam

I = moment of inertia of a beam section x distance from the end of the beam

Perform a differentiation of work with respect to each unknown.

Set each of the derivatives from 2 equal to zero.

Solve the equations resulting from 3 for the required unknowns.

Additional terms needed for the solution of this problem are

B = load concentrated at the end of a rib

P, Q and R = total of all loads B on those ribs having the moment arms a, b and c, respectively

$$W = \int \frac{B^2 x^2 dx}{2\,EI}$$

= total work stored in any head rib

$$= B^2 \int \frac{x^2 dx}{2EI}$$

$= B^2K$, when K is an unknown constant with its value depending on the dimensions of the ribs

W_t = total energy stored in the twelve beams

$= K(P^2 + Q^2 + R^2)$

$D = 13.5 \times 35{,}000 = aP + bQ + cR = D$

= total bending moment applied to the head by the journal reaction

$$R = \frac{(D - aP - bQ)}{c} \quad \text{.....(1)}$$

$$W_t = K\left[P^2 + Q^2 + \frac{(D - aP - bQ)^2}{c^2}\right] \quad \text{.....(2)}$$

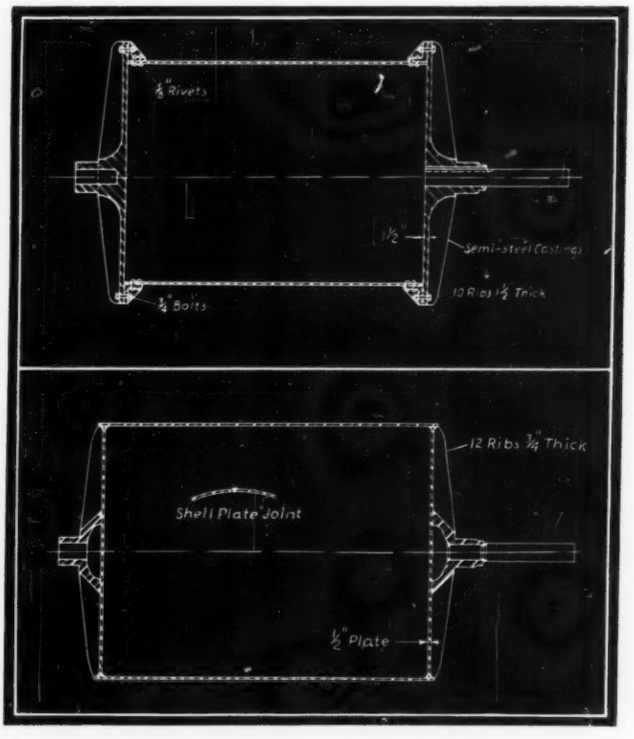


Fig. 3—(Top)—Original design necessitated large patterns. (Below)—Redesigned constructed using welding method

If equation (2) is differentiated with respect to P and the result made equal to zero, the following equation is obtained.

$$Pc^2 + abQ - Da + Pa^2 = 0 \quad \text{.....(3)}$$

If equation (2) is differentiated with respect to Q and the result made equal to zero, the result is

$$Qc^2 + abP - Db + Qb^2 = 0 \quad \text{.....(4)}$$

The following are the numerical values of a, b and c for the position of the head shown in Fig. 4.

$$a = 43.5 \text{ inches}$$
$$b = 32 \text{ inches}$$
$$c = 12 \text{ inches}$$

Equations (1), (3) and (4) were solved simultaneously after the numerical values of a, b and c were introduced. These solutions wielded the following results.

$$P = 6600 \text{ pounds}$$
$$Q = 5100 \text{ pounds}$$
$$R = 1600 \text{ pounds}$$

Each of the above values must be divided by four to obtain values of B, the concentrated load applied to the end of any given rib. If the head is rotated through an angle of 15 degrees from that shown in Fig. 4 another set of values for P, Q and R can be obtained by the method just outlined. These values, together with those values obtained from the first solution, give the following values of B for various values of Θ.

Θ, *degrees*	b, *pounds*
0	0
15	400
30	850
45	1275
60	1530
75	1660
90	1750

The length of the radius vector r in Fig. 4 is equal to a value of B at a corresponding value of Θ. It will be noted that the shape of the resulting polar curve is a circle, within the errors of slide rule computations. This fact furnishes an index to the relative distribution of the rib bending loads. Similar structures can be analyzed by an application of the shape of this curve for the determination of the maximum value of B. It is obvious that for the case being discussed the maximum value of B, 1750 pounds, is the design load for the ribs, considering them as being cantilever beams.

Theoretical Curve Must Be Modified

The actual design of the rib is a rather simple and familiar problem. Since the head plate is not considered as having strength, its only purpose in the rib design is to prevent lateral bending of the ribs. The theoretical curve obtained by designing the rib as a cantilever beam of uniform strength, must be modified at its tip in order that the rib will be wide enough to carry a weld of sufficient length to resist the shear load of 1750 pounds.

Welds connecting the rib to the head casting must be designed for strength equivalent to that of the rib base. The size of shaft weld can be obtained easily by considering the minimum weld section as a hollow shaft subjected to torsion. Welds securing head to shell plate, ribs to head plate and hub casting to head plate are of a rather arbitrary size and must be proportioned by practical considerations.

It generally is conceded that welding is an economical fabrication method. However, many designers feel that this economy is achieved with some sacrifice in the strength and rigidity of the structure. This attitude is not tenable. If proper attention is given to the stress analysis of the welds and the structural members a unit can be developed that will equal or exceed the cast structure in strength and rigidity.

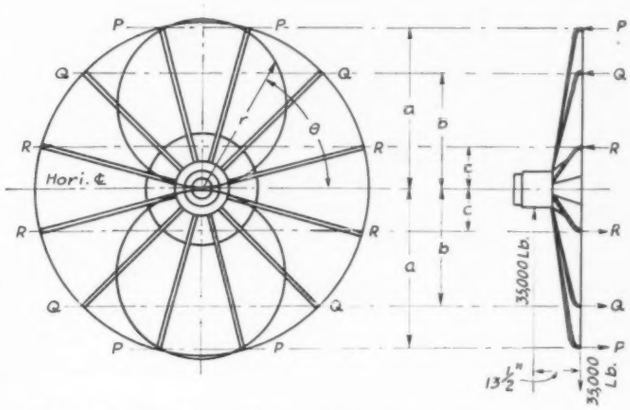


Fig. 4—Diagram used for determining stress in ribs

Speeds Action on Patent Applications

MORE rapid action by the patent office and a considerable falling off in the number of applications received have served to reduce the number of applications awaiting official action to a number smaller than at any time in the last five years, according to Commissioner Thomas E. Robertson. Between January 1 and September 30 this year 52,440 new applications were received, a reduction of 8665 from the 61,105 applications received during the same period in 1931. The increase in filing fee from $25 to $30 has no doubt had considerable influence in bringing about the reduction.

Increased appropriations by Congress, enabling the office to employ 110 additional examiners has made possible a still further reduction in patents awaiting official action. On January 1, 1932, there were 90,274 on hand, while by September 30 this had been cut to 68,105, a decrease of 22,169 or 24.5 per cent as compared with the decrease in new applications of 14.2 per cent. It is expected that the number of applications pending will be below 60,000 by January 1.

Editorial

Where Is Dividing Line between Purchase And Manufacture of Parts?

ONE of the fine points in the good management of a manufacturing establishment is to know whether to make certain parts in one's own shop or to buy them. This question is receiving more than usual attention today because many companies are finding it difficult to justify the operation of foundry, forge, stamping and other departments. In many cases they are closing down these facilities and purchasing castings, forgings, stampings, etc. in the open market.

As industry emerges from the depression, the question will arise as to whether these departmental shops shall be reopened or permanently abandoned. This is a problem of post-depression policy in which the opinion of design engineers should carry considerable weight.

In the past, departments frequently were added to plants with little consideration for their restricting influence on design. Too often, engineers have had to specify "home-made" materials or parts in order to help nurse along unprofitable departments, when it would have been far better for all concerned if the products had been purchased from outside specialists. Of course in large establishments and in smaller ones where peculiar conditions pertaining to certain parts prevail, the operation of foundry, forge or other departments may be warranted.

The important point is that the decision to make or to buy should not be reached through consideration of financial and operating factors alone. It should also take into account the interest of engineering and design, which in many establishments will be found to be the paramount issue in the question.

The Trend Toward Unitization

DESIGN for unit assembly is not new. Any properly laid out design necessarily must incorporate certain basic practices—and this is one of many that have long been employed. Yet there still is a great deal to be done in applying the principle of unit construction to the greatest advantage.

Complete interchangeability of assembled units is one of the features of unit design that up to the present has not been sufficiently considered. Such interchangeability facilitates in many cases the redesign of unit assemblies without fear of changing the entire machine layout, permits stocks of completed units to be carried and enables the same assemblies to be incorporated with ease in different models of similar machines.

Comprehensive treatment of this matter is desirable and MACHINE DESIGN therefore plans to devote considerable space in future issues to the formulation of a new theory on the subject.

Henry Maudsley

Master Designers

Henry Maudsley

EFFICIENT tools and well qualified men—no design can succeed without both. And no man contributed more of each than Henry Maudsley. His was the career of the expert mechanic who, although credited with relatively few inventions, left his impress on every mechanical contrivance and every man contacted. He devised, rearranged and simplified mechanisms and he trained men to broader conceptions of design and production and broader outlooks generally.

BORN in Woolwich, England, in 1771, Maudsley began work in the arsenal at the age of twelve and soon gained recognition for his industry and ingenuity. When Joseph Bramah required a mechanic to build his extremely intricate locks, Maudsley was recommended. Despite his youth—he was only 18—he succeeded, designing tools and processes of unusual merit. It was while he was with Bramah that he made his important contributions to lathe design and invented the self-tightening collar for hydraulic presses.

MAUDSLEY made the lathe an instrument of precision. He devised the slide rest, constructed the first unit made entirely of iron, and developed a technique that made it possible to cut accurate lead screws of some length. This last innovation brought about the abandonment of the traversing mandrel in favor of the more flexible principle of the traversing tool. Maudsley also invented a machine for punching boiler plate and the direct-acting motion for steam engines. He contrived and built forty-four entirely new machines for making blocks used in raising sails.

MANY men who later were to make their own contributions to design were trained by this pioneer in mechanical improvement, including James Nasmyth, Sir Joseph Whitworth and Joseph Clement. Maudsley was extremely interested in the progress and capabilities of his workmen and overlooked no opportunity for instructing, encouraging or advising them. The developments made by his pupils place his efforts in their behalf on a par with his important mechanical achievements. He died in 1831 from a cold contracted while visiting a friend in Germany.

PROFESSIONAL VIEWPOINTS

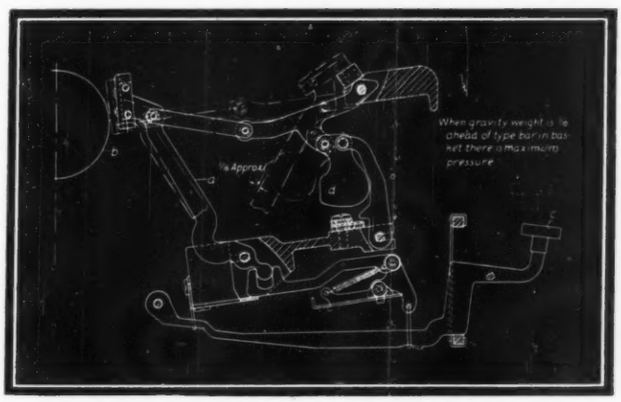
Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments and Questions from Our Readers. Machine Design Will Pay for Letters or Solutions to Problems Suitable for Publication

Solving the Noise Problem

To the Editor:

WITHIN the past few months there has been developed another type of noiseless typewriter action which might prove of interest in connection with your recent series on noise in machines and its elimination. This new principle, which in some respects is the reverse of that used in the noiseless standard or office machine,



Weight acts as a retarder in portable typewriter action to cushion the blow and reduce noise

is utilized on portable models. The standard noiseless typewriter action is not adaptable to the portable machine because of its reduced size and weight.

In the standard models the key lever merely starts a weight in motion. The action of this weight brings the type bar against the platen roll with such exacting pressure that it is possible to use a steel platen roll and secure excellent printing results without noise. In the new action, the weight acts as a retarder instead of furnishing the impetus which provides pressure printing. The lever, *a* in the accompanying illustration, is driven to the platen roll *b* by pressure of the typewriter key *c*, but the weight *d* prevents the type bar from snapping against the platen roll. This has a tendency to slow the bar slightly, but it is gaged so accurately that writing speed is not sacrificed. The weight adjustment permits the key action to carry through with just the pressure needed for noiseless writing.

While noise has been a growing menace since early in the present century, only in recent years has its study and elimination become a definite science. Undoubtedly it is partly coincidence and partly foresight that development of the noiseless typewriter progressed during this period in which noise has increased rapidly. Now, at the time when the importance of noise elimination is fully recognized, the machine which definitely removes din from the business office has reached its peak of efficiency.

—ROSS H. COLLER,
Buffalo.

Perfect Patent Agreements!

To the Editor:

IT SEEMS to me that all employers of technical and engineering talent would save themselves much grief and annoyance if they were to have carefully prepared invention agreements. I know of several instances and I suppose most readers of MACHINE DESIGN have heard of other cases wherein firms have spent much time and money in patent interference cases.

Some companies require new technical men to sign a pre-employment contract in which is stated the company's right to the use of such new processes or inventions as the man may develop. Other companies have contracts with the employes of their development departments which bind the employes to turn over to the company all inventions which they might develop while in their employ. There is a sliding scale of remuneration for effective original work.

Fully half of the total number of employers have no agreement whatever. To say that they are inviting trouble is to put it mildly. Their entire business future might be predicated upon the question as to whether or not they had some such agreement.

Employer-employe agreements are many and

varied and it is advisable to have a patent attorney prepare one adapted to the business in question.

It is equally important for the engineer and chemist to see that his interests are protected. Verbal agreements are difficult to prove. A written agreement is the legal safeguard of both employer and employe.

—J. M. MURPHY,
Lakewood, O.

More and Better Machines

To the Editor:

IN CONNECTION with your interesting editorial on "More and Better Machines" in the October issue, I wish to call your attention to a machine which reduces costs, increases employment, improves working conditions for employes and produces a better product. Such machinery is of the type that is required today to help improve employment conditions. This machine is a new process for dry-scouring strip, sheet, rod and bar to remove the scale and oxide in place of the old acid pickling process.

In planning a recent installation for a production of about 300 tons per 24 hour working day and using actual performance data, the labor requirements were increased 50 per cent over previous figures, and total cost was reduced.

Installation of machines does not always cause increased unemployment, but in cases where automatic machinery does reduce employment the employe is entitled to a readjustment whereby a higher rate will be paid on account of reduced hours. I believe that one of the greatest mistakes made in installation of new machinery and equipment is to expect a new machine to pay for itself from the reduced labor cost in less time than a safe estimate on the number of useful years of life of the machine.

—CHARLES A. DREISBACH,
New Haven, Conn.

Quiet Design Office Noises!

To the Editor:

TWO of the most disturbing elements which tend to impair the engineer's thinking capacity are loud discussions and whistling. In clarifying what the company officials expect of the engineer, it might be well to study the means of eliminating disagreeable factors of this kind in order to give the engineer every possible opportunity to meet the expectations of the management.

When we enter a library reference room we find that general quiet prevails. Talking in an undertone only is permitted. It is taken for granted that noises distract attention. Why then should not the engineering office be conducted on the same principles? Thinking out and solving problems is the engineer's task, why make that task more difficult?

A design office should not be used as a conference room between the chief engineer and other company officials. Often disagreements arise, causing voices to be raised. To the engineer, this creates a contest of wits and he unwittingly awaits the outcome. Naturally he cannot do two things at once, so he takes the line of least resistance, getting amusement from the argument. After all he is human.

The second of these petty annoyances should be altogether taboo. The habitual whistler, while apparently spreading good cheer, unconsciously turns over in his mind the words of the tune. He also starts the other tune-minded fellow who enters the serenade with tenor or bass. The result invariably is the "raspberry" whistle from the rest of the force!

—F. A. FIRNHABER,
Waynesboro, Pa.

Rejuvenating the Veteran Designer

To the Editor:

WHEN sales drop and the shop is silent three days a week, an unprecedented effort must be made to perfect the product of the company and the ideas of yesterday must give way for those that are up-to-the-minute. In times like this the veteran designer is something of a problem. He has, or thinks he has, tried all the wrong ways to do a thing, and likewise thinks he knows all the right ways. Consequently he too often is satisfied to mark time.

Personally I think there is great hope for the veteran and I believe he can be revitalized and rejuvenated with tact and suggestion. To tell him that he and his ways are old only drives him deeper into his rut where he endeavors to persuade himself and others that there is nothing to beat the good old ways; but put in his way up-to-date books and technical publications and tell him you know how he appreciates such literature and he will become interested. Before long he will be "suggesting" to himself that he is mentally wide awake and delighting in new original ideas.

—ALFRED C. LAYZELL,
London, England.

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

AN AMERICAN standard value to be used by industry in converting inches to millimeters was recommended by a conference held under the auspices of the American Standards association on October 21, following a request of the Ford Motor Co. The conference unanimously recommended the conversion factor of one inch equals 25.4 millimeters to become the American standard value, replacing the official ratio 25.40005 and the rounded value 25.4001 given in certain handbooks and tables.

Official British ratio is 25.399978. Thus their value is about one part in a million below, and the American value about two parts in a million above 25.4. British industry, through the British Standards institution, accepted the value 25.4 for industrial use in 1930. Adoption of the conversion ratio 25.4 by American industry will secure world-wide uniformity in conversion practice.

* * *

Discusses Six-Wheel Truck Development

ENGINEERING progress in the development of six-wheel trucks is a topic of more than ordinary interest at the present time. The subject was discussed thoroughly by Austin M. Wolf at the recent transportation meeting of the Society of Automotive Engineers at Toronto, Ont. He referred to road impact tests as evidence of the six-wheel truck's ability to carry heavy loads with less destructive effect to the roads and its own mechanism than would occur with the four-wheel unit.

Mr. Wolf declared that engine capacities must measure up to the work. The trend is toward larger engines and the increased fuel consumption soon will outweigh the possible economy of a smaller engine. An engine of relatively slow speed with high torque output is desirable.

* * *

Packaging Manufacturers Discuss Problems

PACKAGING machinery manufacturers have recognized the need for an organization as indicated by the announcement that a meeting of this group was held Oct. 6 and 7 at Buckwood Inn, Shawnee-on-the-Delaware. The major purpose of this initial gathering was to provide for a better acquaintanceship within the industry and for a discussion of some of the problems.

H. H. Leonard, vice president, Consolidated Packaging Machinery Corp., was elected chairman of a committee to arrange for a meeting during the American Management association's packaging conference and exposition in New York in March, and for another meeting in the autumn of 1933.

* * *

Supreme Court Rules Radio Patents Invalid

VALUABLE patents on devices enabling radio receiving sets to operate on ordinary alternating current were ruled invalid by the United States supreme court recently, according to the United Press. Dubilier Condenser Corp., holder of the patents, charged that the Radio Corp. of America was infringing them. The federal circuit court at Philadelphia held the patents invalid and the supreme court affirmed this decision by denying a review.

In another important patent decision, the court refused to review the unsuccessful suit of Glenn H. Martin, well-known aviation engineer, to collect royalties from the government on a lubricating system which, he claimed, was used on Liberty airplane motors during the World war. A lower court has ruled Curtiss' patents invalid also.

* * *

New Dictionary Lists Electrical Terms

CONFUSION resulting from conflicting electrical definitions used in different engineering textbooks and by different technologists and teachers of engineering soon will be eliminated. A proposed dictionary of electrical engineering terms, representing the results of over three years' work by a committee of 120 scientists and engineers under the chairmanship of Dr. A. E. Kennelly of Harvard university, has been published for review and criticism prior to its submittal to the American Standards association for adoption as an American standard.

The report, prepared under the direction of the American Institute of Electrical Engineers, is a document of 208 pages listing over 3400 interpretations ranging from the fundamental definitions on which the science of electricity is

(*Concluded on Page* 51)

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

OUTSTANDING both as an educator in the engineering field and as a designer, Roy A. Seaton, dean of division of engineering, Kansas State college, Manhattan, Kans., has been made president of Society for the Promotion of Engineering Education. This honor was bestowed upon him at the recent annual meeting of the organization. He is a graduate of the engineering course at Kansas State college and of Massachusetts Institute of Technology.

In 1911-12 he put aside teaching to engage in the design of steam turbines, centrifugal air compressors and other high speed machinery. During the World war, February to November, 1918, Dean Seaton served as captain in the office of the chief of ordnance at Washington and worked on the development of artillery ammunition. He holds the distinction of having made the official computation for the war department on the ballistics of long range shells fired by the Germans on Paris as well as having determined the type of gun firing such shells and the use the United States might be able to make of such a gun.

After the war he became a member of the faculty of the department of machine design at Kansas State college, and in 1920 was made dean of the division of engineering and director of the engineering experiment station. Dean Seaton has been secretary and later chairman of the engineering section of Land Grant colleges and is a member of the American Society of Mechanical Engineers, Phi Kappa Phi, Sigma Xi, Sigma Tau, and fellow of the American Association for the Advancement of Science.

METALS, their properties and the problems involved in selection, being of uppermost importance in the minds of designers of machinery it is natural that the activities of American Society for Steel Treating should be of interest to the machine design profession. In the society's new president, W. B. Coleman, the machinery industry sees a capable executive.

As head of W. B. Coleman & Co., Philadelphia, he supervises consulting work in metallurgical engineering covering various phases of open hearth and electric steel manufacture; processing of steel and heat treatment, and laboratories for chemical analysis and metallurgical and physical testing. Mr. Coleman is a graduate of Hill high school, Pottstown, Pa., and the University of Pennsylvania. He was in charge of foundry and open hearth furnaces at the plant of the Midvale Steel Co., Philadelphia, following which he was appointed superintendent of the open hearth department, Coatesville, Pa., works, Midvale Steel & Ordnance Co.

Subsequently Mr. Coleman was affiliated with the Tacony Steel Co. and during the World war was civilian consultant on all gun steel manufacture to the ordnance department, Washington.

IN RESPONSIBLE charge of the extensive work on fuels, lubricants, internal combustion engine problems and automotive projects carried on by the bureau of standards, Dr. H. C. Dickinson possesses a unique background. He is the 1933 presidential nominee of the Society of Automotive Engineers in which he has held membership since 1918. In 1921 when the research department of the society was instituted, he became its manager and continued in that capacity for two years.

Born in Bangor, Maine, October 11, 1875, Dr. Dickinson studied at Williams college and later at Clark university, obtaining his Ph.D. degree from the latter in 1910. His association with the bureau of standards began in 1903 when he engaged in experimental laboratory work on problems of heat, thermometry, calorimetry and thermodynamics of internal combustion engines. Since 1922 he has held the position of chief of the heat and power division of the bureau.

Dr. Dickinson holds many important offices on technical committees of the government and associated organizations. In addition to having been the author of many outstanding technical articles, he holds membership in several engineering societies.

TWENTY-TWO years, his entire business career, with one company is the record of Henry S. Beal who recently was elected president of the National Machine Tool Builders' association. As general manager of the Jones &

Leaders in Design, Engineering and Research

ROY A. SEATON

W. B. COLEMAN

H. C. DICKINSON

HENRY S. BEAL
—*Bachrach*

Lamson Machine Co. he has had the opportunity of acquiring a keen picture of the machine tool industry and its problems.

A native of Rockford, Ill., Mr. Beal attended Dartmouth college, Hanover, N. H., for two years and studied later at the University of Berlin for one year. After he left school in 1910, he entered the employ of the Jones & Lamson company, starting in the shop and advancing steadily to assistant general manager. At the end of five years he was made general manager. That was six months ago. For six years Mr. Beal has been active in the affairs of the National Machine Tool Builders' association, having been second vice president prior to his election as head of the organization.

* * *

A. R. Petterson, formerly chief engineer of New England Wire Machinery Co., will have charge of sales and engineering work in the department recently established by Thomson-Gibb Electric Welding Co. for the manufacture of a complete line of wire mill and stranding machinery.

* * *

John Toth, formerly connected with Brown & Sharpe Mfg. Co., Providence, R. I., as design engineer, now is employed as a development engineer with Atwood Machine Co., Stonington, Conn.

* * *

George G. Thorp, President, Illinois Steel Co., has been elected to the board of trustees of Armour Institute of Technology, Chicago. Mr. Thorp is a graduate in mechanical engineering of the University of Wisconsin.

* * *

R. C. Cosgrove, manager, refrigeration division, Westinghouse Electric & Mfg. Co., has been placed in charge of the company's domestic air conditioning activities in addition to his present duties. He is a graduate of Carnegie Institute of Technology and joined the company in 1919.

* * *

Herman A. Wagner, consulting mining and metallurgical engineer, Chicago, recently was awarded the second Clausen gold medal of the American Association of Engineers for distinguished service performed in behalf of social and economic welfare work for the engineer.

* * *

Glenn E. Weist, formerly sales engineer with the Milwaukee Electric Hoist division of the Harnischfeger Co., Milwaukee, has joined the Kron Co., Bridgeport, Conn., manufacturer of automatic dial scales. Mr. Weist will be in charge of engineering. He is a graduate of Purdue university and has had a wide experience in the engineering field.

* * *

William Bardenheuer, formerly chief engineer of Brunswick-Kroeschell Co., Chicago, recently joined the production design department of Carrier Engineering Corp., Newark, N. J.

* * *

J. P. Den Hartog, since 1931 chief of the dynamic section of Westinghouse research laboratory, has been appointed assistant professor of applied mechanics at Harvard university.

* * *

S. H. Mortensen has been appointed engineer in charge of alternating current design for the Allis-Chalmers Mfg. Co., Milwaukee, to succeed the late R. B. Williamson. Mr. Mortensen was first assistant to Mr. Williamson for many years.

* * *

Nathaniel B. Wales, inventor of a number of mechanical products including the Kelvinator refrigerator, recently became associated with the G. M. Basford Co., New York. He is in charge of engineering and research in the new products development division of the company.

* * *

Clayton R. Burt, president and general manager of the Pratt and Whitney Co., Hartford, Conn., and a member of the board of directors of the National Machine Tool Builders' association, has been elected to membership on the board of directors of the American Standards association.

* * *

Frank P. McKibben, consulting engineer and president of the American Welding Society, was awarded the Samuel Wylie Miller medal at the society's Buffalo meeting recently, in recognition of his work in the development of welded steel structures. A biographical sketch of Mr. McKibben appeared in the July, 1932, issue of MACHINE DESIGN.

* * *

George H. Charls has resigned as president and treasurer of the National Association of Flat Rolled Steel Manufacturers to become assistant to Robert P. Lamont, new president of the American Iron and Steel Institute.

* * *

J. S. Tritle, vice president and general manager of the Westinghouse Electric & Mfg. Co. was elected president of the National Electrical Manufacturers' association to succeed John H. Trumbull, former governor of Connecticut, at

the recent annual meeting of the organization. A biographical sketch of Mr. Tritle appeared in the August, 1931, issue.

* * *

W. H. Phillips, vice president, Molybdenum Corp. of America, Pittsburgh, was made vice president of the American Society for Steel Treating at the recent annual meeting in Buffalo. New directors are: R. S. Archer, director of research, A. O. Smith Corp., Milwaukee, and H. G. Keshian, metallurgist, Chase Companies Inc., Waterbury, Conn.

* * *

Dr. Fredrich Sass, chief engineer, diesel division, Allgemeine Electricitats Gesellschaft, Berlin, Germany, recently returned to Germany after a six-week tour of various diesel engine manufacturing plants in this country. While here he presented a paper entitled "Some Recent Developments in Double-Acting Diesel Engines," before the oil and gas power division of the American Society of Mechanical Engineers.

Obituaries

ADOLPH LOMB, vice president of Bausch & Lomb Optical Co., Rochester, N. Y., recently died of pneumonia at his home in Pittsford, N. Y. He was 66 years of age. For 53 years he had been connected with the company of which his father was co-founder. In 1892 he graduated from the University of Rochester, later taking postgraduate work at Massachusetts Institute of Technology and at the University of Berlin, Germany.

* * *

Maurice Dornier, co-designer with his brother Claude, of the giant flying boat DO-X, died recently at Munich, Germany. He was 44 years old. Death resulted from an operation for a stomach malady contracted while he was serving in German East Africa during the World war. In 1924 Maurice joined his brother in the Dornier Works and was one of the passengers who made the transatlantic flight in the DO-X in 1931.

* * *

Dr. Frank Leroy Slocum, 76, consulting engineer, chemist and metallurgist in several Pittsburgh companies for nearly 50 years, died in Pittsburgh recently. He was born in Lima, Wis. His business associations at various times included Park Bros. & Co., Pittsburgh, later absorbed by the Crucible Steel Co. of America; Mackintosh-Hemphill Co., Pittsburgh, Carnegie Steel Co., Pittsburgh, and Firth-Sterling Steel Co., McKeesport, Pa. Besides holding patents on several mechanical and chemical developments, he was the author of numerous technical works.

TOPICS OF THE MONTH

(*Concluded from Page* 47)

based to definitions for practical applications. Nearly 200 individuals, in addition to the 120 serving on the committee and subcommittees, participated actively in the work.

* * *

W. B. Stout Sees New Engineering Era

ENGINEERING will offer unprecedented opportunities when the world emerges from its business lethargy . . . more new things will be demanded than ever before. Thus spoke William B. Stout, pioneer airplane designer, at a meeting of the Society of Automotive Engineers recently.

After discussing cars he commented on the railroad industry: "The trouble with the railroads is that they are mechanically sick, that is, their machinery has run down. They are running 130,000-pound cars to carry six passengers, whereas 13,000-pound cars would do the job better and at less cost. Rolling stock was designed in the days when we had only cast iron, wrought iron, steel and tool steel, and the railroad man's ideas of engineering have not changed to keep pace with the development of alloys and scientific heat treatment of steel."

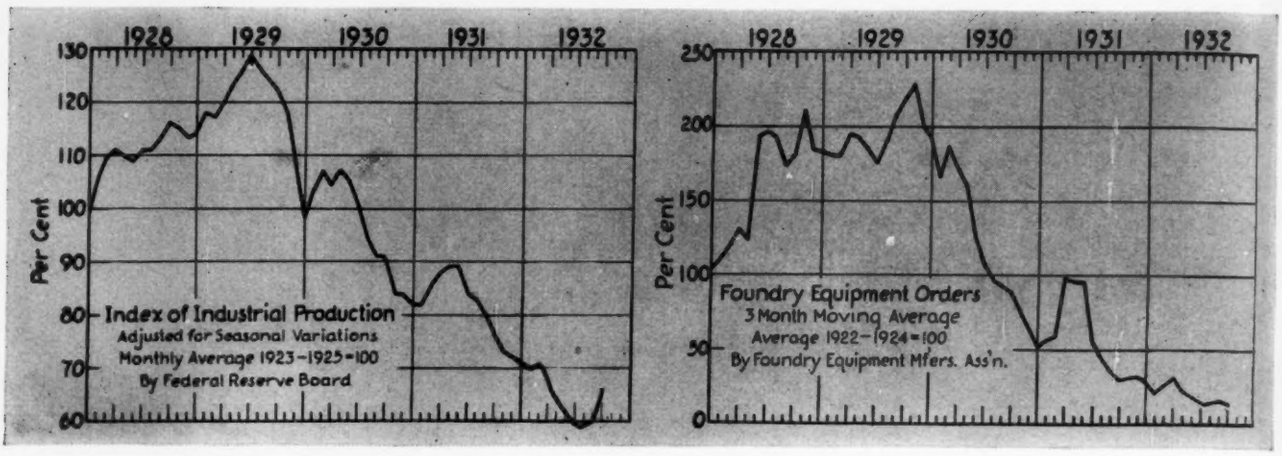
Considered to be the most outspoken critic of the automobile, Mr. Stout soon will have an opportunity to test his theories. Word comes from Detroit that he is organizing a company to back him in his experiments. The designer denies that he is concerned with manufacture, at least for the present. It is said it will take a year before his ideas are tested thoroughly.

* * *

Rehabilitation Group Holds Meeting

AT THE call of Frederick A. Geier, president of the Cincinnati Milling Machine Co., a meeting was held last month to lay plans for sending representatives into all types of industrial and business houses to show advantages of modernizing plants now. This marked Mr. Geier's first step as chairman of the committee on industrial rehabilitation for the Cincinnati area.

Figures were cited to show that since 1929 expenditures for equipment, machinery and plant facilities have declined from an annual outlay of $5,000,000,000 to a yearly expenditure of $1,260,000,000. This means, Mr. Geier said, that more than 50 per cent of the equipment of American factories is obsolete. Replacement has not kept pace with engineering advancement.

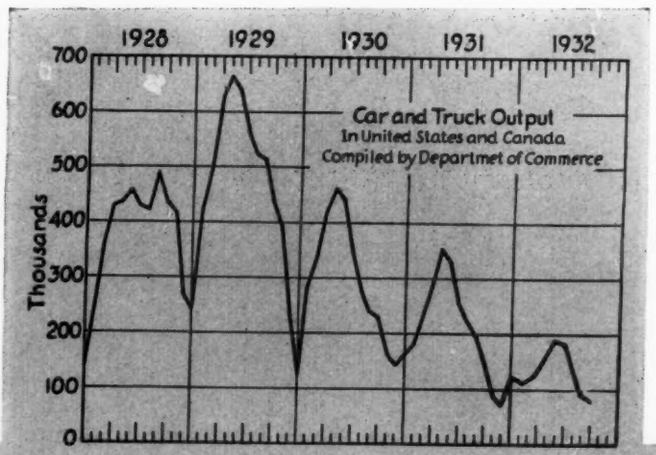


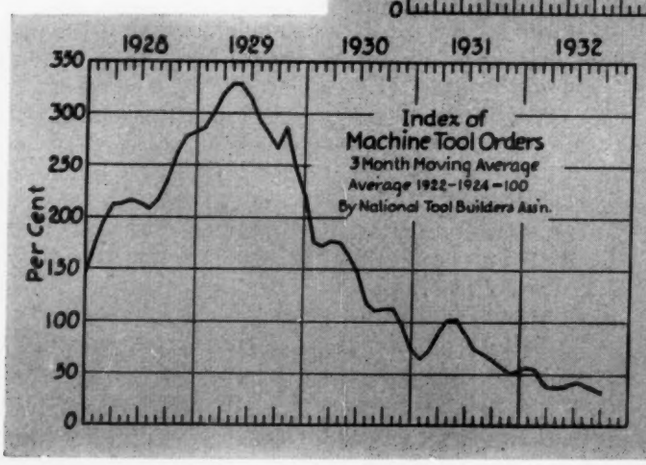
How Is Business?

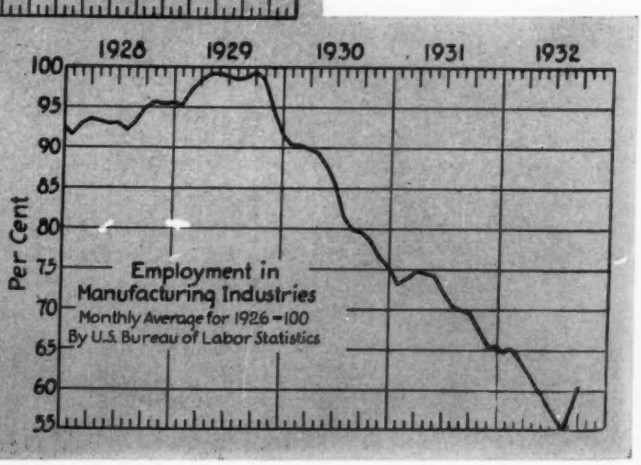
IT HAS been a great many years since a presidential election had such an adverse effect on business sentiment as the one just concluded. A large number of actual orders were to be held until after the results were known, and business relapsed to a state of watchful waiting. There were many dire prophecies made by both parties, and now the truth of these prophecies will be tested.

Despite this braking tendency of the political controversy, indications of recovery continued, evidencing considerable more life than did business sentiment. Greater than seasonal gains were registered in many indexes, while practically all were able to conform to the seasonal trend. Most encouraging were freight car loadings which continued to rise for three weeks longer than normal, steel operations which touched 20 per cent for the first time since June and electric power output.

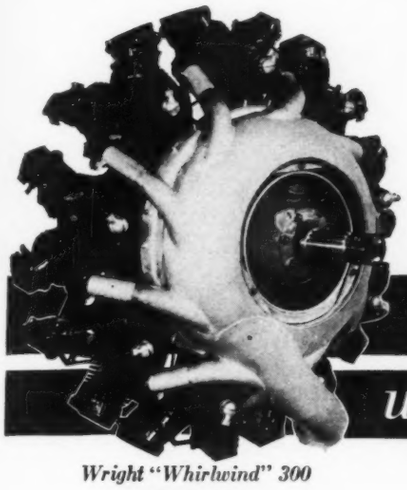
Foreign trade showed the best favorable balance registered this year, while employment in manufacturing industries bounced upward 4.5 per cent, payroll totals increasing 5 per cent. The growing tendency to spread work should aid the employment index considerably, while the mere fact that there is some work to be had should bolster retail sales, the basic improvement needed for all industry. That the gains already made have aided in this field is evidenced by department store sales which doubled their usual seasonal gain. Other fields have shown equally encouraging expansion and expect further improvements.





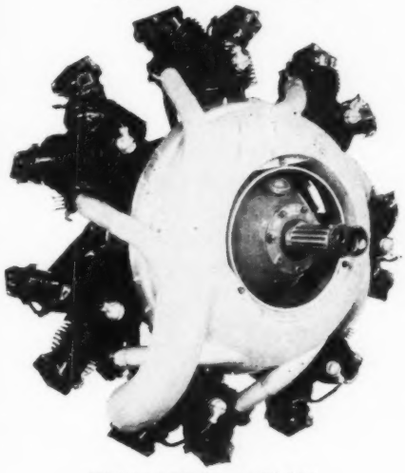


Eliminating Risk *from* Air Travel



Wright "Whirlwind" 300

Wright "Whirlwind" Engines *use* MRC-SRB BALL BEARINGS



Wright "Whirlwind" 240

Wright "Whirlwind" 165

MRC-SRB Ball Bearings have been used on Wright Engines for the last ten years. To any engineer this should be convincing evidence of their dependability. Bear in mind, too, that Wright is not alone in its high regard for MRC-SRB Ball Bearings . . . practically all American Aircraft Engine Builders use them.

When Ball Bearings are required for exacting performance, specify MRC-SRB—they have the endorsement of an industry that demands DEPENDABILITY.

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NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

NOISE and vibration, constant enemies of the designer, yield to a remarkable degree when rubber and similar nonmetallic materials are employed. A recent patent, No. 1,881,800, covers the construction of a propeller shaft bearing which typifies one method of attacking the problem of eliminating these factors. The invention relates to the mounting of power units and associated parts for marine use, and was conceived by Alfred F. Masury for the Rubber Shock Insulator Corp., Wilmington, Del.

Because the hull and superstructure of boats form an effective sound and vibration transmitting means, the elimination of these objectional features has long been an important object in boat designing. In Fig. 1 is shown the mounting of a propeller shaft within a hull by means of a bearing secured to the hull through nonmetallic cushioning elements whereby vibration and irregularities in the transmission of power will be isolated from the hull.

Propeller shaft a, mounted on rib a^1 of the vessel, is carried on the rib by bearing casting b which has a housing b^1. Arms b^2 are formed with seats b^3 and b^4. Locknut a^4 holds the ball race in position on the shaft. Bearing housing b^1 carries a second ball race which co-operates the race mentioned in the foregoing, and is held in position by a second locknut b^7.

Ends of arms b^2 are secured in the nonmetallic elements c. A housing d is fastened to rib a^1 and caps d^1 are adapted to confine the blocks c under compression. The degree of compression under which blocks c are carried may be varied by means of bolts at either side of caps d^1. The entire housing is shown, Fig. 1, as secured to rib a^1 by means of bolts d^3. Blocks c are formed with recesses which are designed to receive the ends of arms b^2 carrying seats b^3 and b^4.

Although the mounting for the bearing of the propeller shaft is of a yielding character, cushioning the vibration, the mounting is sufficiently positive to prevent an excessive movement of the shaft under the stresses which create the vibrations. This is obtained by maintaining the cushioning members under considerable pressure. Under such conditions vibration is deadened effectively without permitting appreciable movement of the shaft with respect to the mounting.

TO PREVENT motor overload with consequent circuit blow out, a safety device in the form of a throw-off has been designed to disengage a driven member from its connection with a driver. The mechanism is intended particularly for use in connection with bake ovens. Albert H. Rancke is the inventor with Petersen Oven Co., Chicago, assignee. Number of the patent is 1,879,486.

Designed to be interposed between the motor or power shaft and the gear reduction unit, the throw-off mechanism is constructed so that when an overload occurs it will disconnect the driving and driven elements automatically. Components of the device consist of a plate 16 mounted on the reduced portion of the bushing 12, being free to rotate upon the bushing. The face of the plate next the collar 13 is provided with a number of shoulders. Pulley 17 for connecting the structure with the gear reduction apparatus is bolted on one of these step portions, Fig. 2.

The opposite face of the plate 16 is designed with lateral lugs 18 arranged concentrically

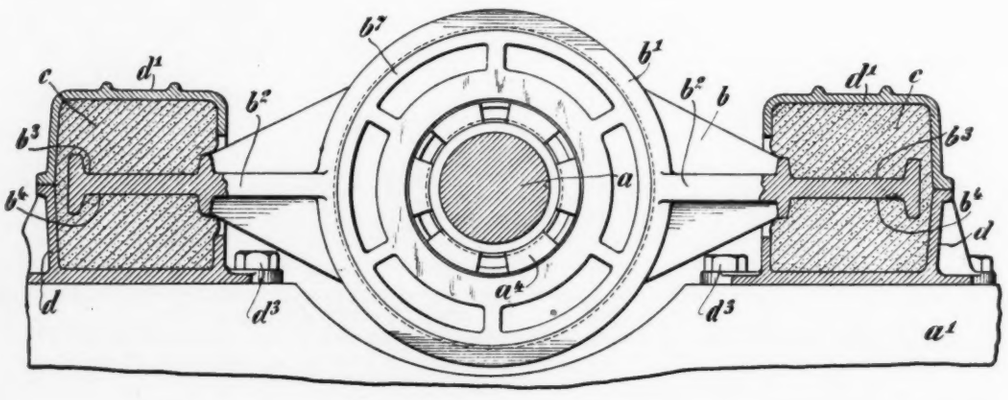

Fig. 1 — Nonmetallic cushioning elements under compression are utilized as a mounting for a propeller shaft bearing to form an effective means for reducing vibration and noise

around the central opening in the plate. Each lug has a wedge or cam-shaped face 19 that inclines upwardly away from the adjacent surface of the plate to provide the members that cooperate with other members to form the clutch. Depressions or sockets 20 in the tops of the lugs engage the rounded ends of studs 22.

Plate 21 has a bore slightly greater than the diameter of head 12 of the bushing and is positioned adjacent the radial projections 15. The face of plate 21 nearest the radial projections 15 is provided with lateral projections 24, the sides of which are engaged normally with projections 15 on the head of the bushing. When the shaft is rotated the interengagement of these projections 15 and 24 causes plate 21 to rotate and thereby revolve pulley 17 mounted upon plate 16 toward which plate 21 is urged by coil springs 29.

When a drag or stoppage occurs in the mechanism actuated by this apparatus the tendency of the pulley and disk 16 will be to stop, while the motor shaft 10 and its bushing will continue rotation, thus causing projections 15 to press tighter against pins 24. This causes studs 22 to ride out of sockets 20 and move down the inclined faces 19, due to the springs urging plate 21 toward plate 16. Projections 24 thereby are moved out of the path of pins 15, permitting the shaft and its head to continue rotation.

Movement is effected that will cause the pins 24 to move farther along in engagement with

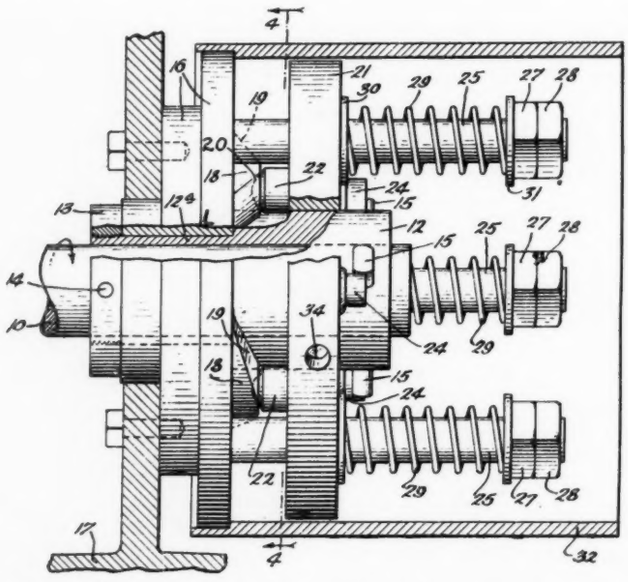

Fig. 2—Throw-off mechanism which is employed to disconnect driving and driven elements when overload occurs

radial projections 15 on the head or end of the drive shaft, and when the studs ride down from the highest edges of inclined faces 19 there will be a further or reverse movement of pins 24 against pins 15, until such time as the ends of one set of pins move out of the path of the other set. This under certain conditions might create too much friction or might too long delay the disengagement of the respective sets of pins. In order to hasten disengagement and reduce friction a modification of the structure was included in the patent.

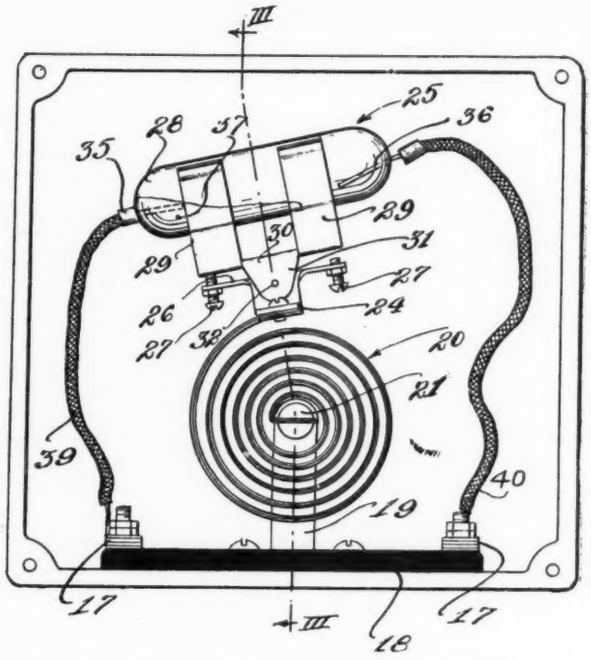

Fig. 3—Thermostatic material and mercury switch combined to be operated by temperature changes

COMBINING a mercury switch and a coil of thermostatic material, Charles L. Rayfield has devised a thermostatically controlled switch which is simple and inexpensive to manufacture. A patent covering the unit recently was issued, having been designated No. 1,881,-950 with the Rayfield Mfg. Co., Chicago, as assignee.

Properties of thermostatic metal in the form of bimetal was discussed at length by Howard D. Matthews in the August, 1932, issue of MACHINE DESIGN. Therefore the reaction of this type of material to changes in temperature will not be described here. It might be reiterated however, that where a rotating motion is desired the material is used in coil form.

Returning to the patent, it is interesting to note that Mr. Rayfield utilizes the thermostat itself as a mounting for the switch, Fig. 3. The coil of thermostatic material 20 is supported by bracket 19. Inner end of the coil 20 extends into and has a tight fit in a slot formed in one end of stud 21. The outer end of this coil has anchored to it a bracket 24 which carries a mercury switch 25 of conventional construction.

Adjustable studs 27 serve not only to limit the tilting movement or travel of switch 25, but also act as a means for determining the amount of movement of the coil necessary before the switch is tilted to either of its two positions.

SWEET VIOLETS

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It certainly is gratifying when a purchaser of equipment writes in with a bouquet of violets regarding how well it does its work.

But the Brickbats! What a kick in the pants it is when the users write in and raise particular hell because the so-and-so equipment hasn't stood up.

It all goes to prove that it isn't enough to DESIGN fine equipment unless you FOLLOW THROUGH by guarding it against breakdowns through Alemite High Pressure Lubrication Systems and the specification of the CORRECT Genuine Alemite Lubricants which will keep that equipment running at full production pitch year in and year out.

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NEW MATERIALS AND PARTS

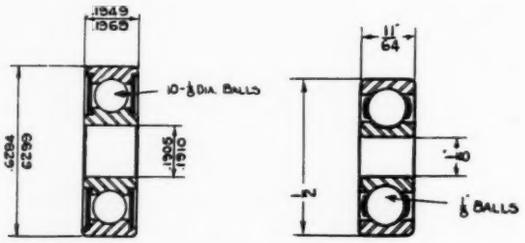
Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Small Sealed Bearings Are Announced

THREE new ball bearings of small size have been developed by Fafnir Bearing Co., New Britain, Conn. The double seal type, shown at the left in the illustration is the smallest offered in this design by the company. It comes prepacked with lubricant, and has the full ball complement for maximum static capacity. This bearing is made also in an intermediate small size, slightly larger in dimensions and capacity.

The miniature design, shown at the right, is said to be the smallest, lightest ball bearing ever made. It is especially adaptable to instruments and other light, delicate bearing applications.

Both completely assembled units are precision ball bearings in every respect. They are small



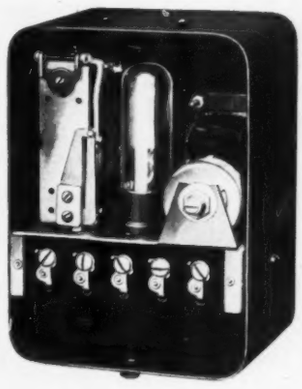
Precision ball bearings in unusually small sizes may be obtained with seals which protect against dirt and grit and retain lubricant

enough to be adaptable to many applications not hitherto possible. Seal types completely protected against dirt and grit retain the lubricant for long periods.

Relay Operates on Quick Changes

OPERATING on light impulses of one-fifteenth of a second duration the new photoelectric relay designed by General Electric Co., Schenectady, N. Y., is applicable to installations where practically complete interception of the light beam is made, since changes of light intensity of at least 50 per cent are necessary for successful operation. The relay, shown herewith, consists of a phototube, a Pliotron amplifying tube, a sensitive relay, an adjustable potentiometer and associated apparatus, all mounted on a steel base.

A cover with one opening for the phototube



Changes of light intensity of 50 per cent or over will operate small sized relay

and another for the potentiometer adjustment is proved. This cover may be replaced by one with an optical system should the application require it. Where the interrupting capacity of the sensitive relay contact is not sufficient to handle the device to be controlled, a small contactor or magnetic switch may be interposed between the sensitive relay and the controlled device.

Pump Parts Can Be Included in Design

STANDARD rotary pump parts, including a cover, idler pin, idler and rotor are being offered by Tuthill Pump Co., 131 West Sixty-third street, Chicago, for incorporation in the design of machinery. Complete dimensions are furnished by the pump manufacturer to insure proper machining. All diameters of the boring are concentric in the parts to facilitate machining. The only requirement is that the ports must communicate with the cored recesses in the parts

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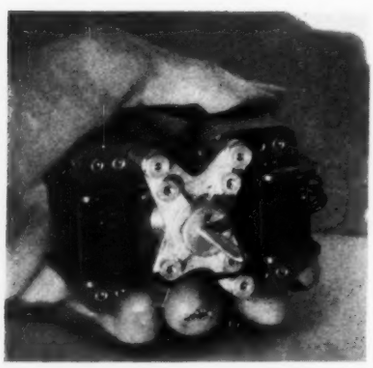
and be large enough to keep the velocity of the pumpage down to a figure consistent with its viscosity.

Port passages may be drilled or cored in any number of arrangements which the designer may choose. Under this system, the builder of the equipment is permitted almost any combination of port arrangement with assurance of a compact pumping unit. The intake and discharge ports will interchange when the direction of shaft rotation is reversed.

Shaded Pole Motors Have Slower Speed

SHADED pole motors which run at a slower speed than previous models with no sacrifice of starting torque or efficiency have been announced by Barber-Colman Co., Rockford, Ill. These motors, shown herewith, are of the core type of the same general design as other models except that they have four poles and therefore run at approximately half the speed. With this construction the "synchronous" speed is 1800 revolutions per minute. At full load the motor delivers 0.0035 horsepower at 1300 R. P. M. with an input of 23 watts at 115 volts, 60 cycles. Starting torque is 0.2 of a pound inch. Current drawn by the motor when stalled is but little more than when running at full load.

Two field coils are used, wound on phenolic resin spools and connected in series. There are two shading rings on each of the four poles. The hardened and ground shaft, 0.1845-inch diameter, runs in oilless bearings. This type of motor is suitable for driving a variety of mechanisms such as pumps, fans, advertising devices and similar equipment.



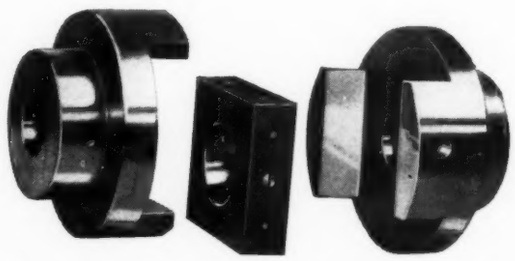
Slower speeds in extremely small motors are possible with new four-pole type

Nut Lock Suitable for Any Size Nut

AN AUTOMATIC nut lock which locks any style nut now is being marketed by Ohio Equipment Co. Inc., 5716 Euclid Ave., Cleveland. The lock unlocks by giving the nut a quarter turn backward with an ordinary wrench. Locking action is obtained by flat spring wire placed in a slot which extends the complete depth of the nut at one corner and is bent over to meet the bolt threads. The wire closely fitting in the slot causes the free end of the lock to make a pressure contact on the bolt threads when the nut is run on. This contact resists backing off and vibrational forces. When the nut is to be released, a quarter turn pushes the lock away from the nut and reverses the slant with relation to the center line of the bolt, allowing the nut to be turned off easily. The fastening is made in sizes ½-inch and larger and the company can apply the lock to nuts furnished by manufacturers.

Coupling Employs Only Three Parts

PROVIDING complete flexibility with only three parts, the new coupling designed by D. O. James Mfg. Co., 1114 West Monroe street, Chicago, has a center member made of non-metallic material self-lubricated by means of a reservoir within itself. The floating center member of the unit, shown herewith, slides between the jaws of one metal flange on a line passing through the center. It is free to slide across the face of the second flange in a direction which is at right angles to the first, making it mechanically flexible without the use of flexible materials. The two metal flanges are made of nickel iron of high tensile strength.



Non-metallic material used as center piece in new coupling is lubricated by means of a reservoir within itself

Stress Is Equalized in New Belting

EQUALIZATION of the stresses developed in the plies is accomplished in the new compensated belting brought out by Manhattan Rubber Mfg. division of Raybestos-Manhattan Inc., Passaic, N. J., by a special method of manufacture designed to balance the stress when the belt is flexing around large or small pulleys. It is

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General Electric Company
140 Federal Street
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Gentlemen Attention of Mr. J. R. Maddock - Sales Agent

SUBJECT: General Electric Gear-Motors

It has occurred to us that you might be interested in the reactions of our customers to your new gear-motors and so we are pleased to give you the following report as to their advantages:

1. You can give us practically any speed we require for driving Kinney Pumps even where accurate quantities are required.
2. The complete unit of pump and motor is very compact.
3. The entire unit is practically noiseless.
4. The pump is readily accessible for inspection and repairs.
5. No thrust is transmitted from the motor to our pump shaft.
6. This type of gearing with its quiet operation is acceptable to many of our customers who formerly objected to the noise of the gear and pinion drive.
7. As compared with building a reduction gear in the head of our pump, this unit has the further advantage that the gears can be lubricated with the proper grade of oil instead of being lubricated by the material being pumped, or, if the gear case were filled with oil, running into the danger of contamination from the material being pumped.

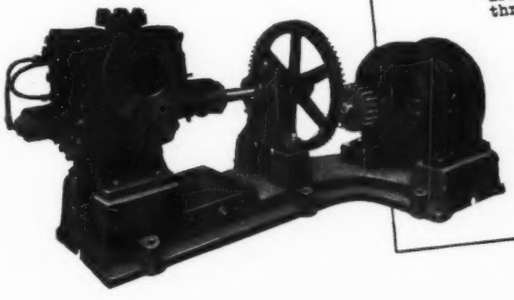
The photographs illustrating our gear driven unit and the new unit using your motor direct connected through flexible coupling speak for themselves.

Very truly yours

KINNEY MANUFACTURING COMPANY

William E. Worcester
William E. Worcester
Vice President in Charge of Sales

BEFORE



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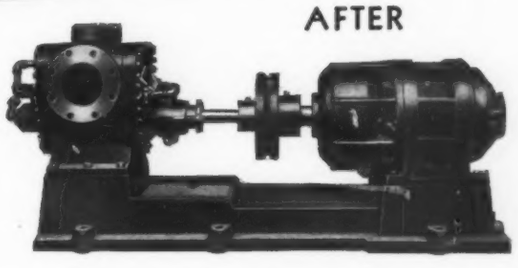


The G-E gear-motor delivers full-rated horsepower at the output shaft at the low speed you desire. The simplicity, compactness, and efficiency of this unit are available not only for pumps but also for conveyors, compressors, machine tools, and many other industrial applications.

Information on the complete line of gear-motors can be obtained from the nearest G-E sales office or G-E Motor Dealer, or from General Electric Company, Schenectady, N. Y.

200-659

GENERAL ELECTRIC

claimed that no trouble will be experienced from ruptured outside plies. Balancing the tension also reduces the tendency for fasteners to work loose and pull out. A specially treated pulley surface increases the coefficient of friction. The belts, which may be made endless, are furnished with from 2 to 8 piles in widths of from 1 to 48 inches.

Develops Stoker Drive Units

DRIVE units for driving both fan and screw of underfeed domestic and industrial stokers are a recent development of Foote Bros. Gear & Machine Co., 5301 South Western boulevard, Chicago. The design of this industrial drive consists of a hardened and ground worm integral with the shaft which drives a bronze worm gear. This gear has a bronze eccentric cast integral and the eccentric drives a hardened steel driving yoke which reciprocates on the eccentric and drives the pawls which engage a hardened cut tooth ratchet wheel keyed to the slow speed shaft by the shear keys. The ratchet wheel is bronze bushed and the hub is extended and runs in a bronze bushing.

Designs Vertical Motorized Reducers

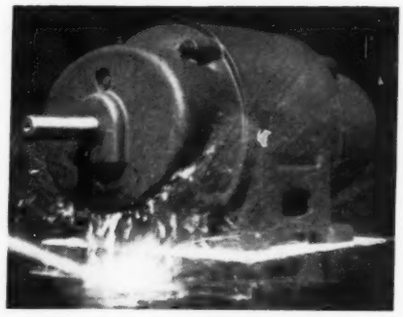
VERTICAL units in the line of MotoReduceR equipment announced by Philadelphia Gear Works, Philadelphia, in the October issue, have been developed by the company. These reducers, shown herewith, have the same operating equipment as the horizontal units. They are available in single, double and triple types with ratios up to 450:1 and can be furnished with standard open type or totally enclosed fan cooled motors, polyphase or single phase. Direct current motors up to ten horsepower may be incorporated in the unit.

All gears in vertical motorized reducer are made from heat treated nickel steel, have helical teeth and are run in an oil bath. Bearings are of the antifriction type

All gears are made from heat treated nickel steel with helical cut teeth and all bearings are of the antifriction type. The slow speed shaft is mounted on roller bearings which compensate for upward or downward thrust and take care of the side whip of the extended vertical shaft. This construction eliminates the use of the step bearings.

Splashing Liquid Is Kept from Motor

PROTECTION against water splashed under pressure from any angle is afforded by the new motor built in the same dimensions as standard open motors by Louis Allis Co., Milwaukee. A double baffle in an elliptically shaped air passage in each end-bell provides the protection offered by this motor, shown herewith. The construction permits free passage of air, yet it traps and drains water splashed into the air openings at the bottom of the chambers. Another feature is a shaft guard which breaks the force of a stream directed along the shaft extension and prevents water from entering the bearing chamber. The new motor eliminates the necessity for sheet metal covers which might restrict ventilation. It is suitable for applications in dairies, meat packing plants, canneries, breweries, paper mills, boiler rooms and locations of a similar type.



A double baffle in an elliptically shaped air passage provides protection for enclosed motors

We are approaching the time when we will no more tolerate a clash in color values or inartistic elements of design than we would permit clashes of mechanical parts of our apparatus, according to Donald R. Rohner director of the art-engineering department of Westinghouse Electric & Mfg. Co.

Reducing Bearing Friction by Special Design

(*Concluded from Page* 30)

number of balls of somewhat smaller size. Dividing the load among more balls reduced the load per ball and the size of the contact area. This effect, combined with the flatter curvatures, was estimated to reduce the friction to one-half or less. Whether the dynamometer sensitivity would be improved sufficiently could not be determined without actually building the bearing and installing it.

Friction of Bearing Decreased

After installing the new bearing a measurement of the zero reading showed 3 pounds total at 21 inches or 1.5 pounds each way. The friction was halved, making the coefficient approximately 0.0008. It also was noticed that the friction increased somewhat erratically after a fraction of a turn, but this effect had no direct bearing on the immediate problem. The dynamometer sensitivity was still too coarse. A considerable improvement had to be found.

After careful consideration of the factors involved, the special arrangement shown in Fig. 2 was designed. The pivot bearing itself was to be mounted on an auxiliary base and rotated continuously in one direction at a slow, steady speed. Bearing friction then would produce a constant, steady drag in one direction, and it could be subtracted as a zero setting or subtracted from each reading.

This arrangement was installed readily in the same space by employing two bearings of the same size opposed to each other, with a floating ring between the inner races. The ring rotates by means of gear teeth cut on the outside, a small countershaft and a worm drive all mounted in a new base casting. The worm is coupled to a fractional horsepower motor at one side. Fig. 1 shows the arrangement.

Sensitivity Is Improved

The new mounting improved the sensitivity of the dynamometer more than was expected and fulfilled the needs of this application. The only error remaining was that due to small variations in the bearing friction itself. Sensitivity of the dynamometer no longer could be measured directly as a zero reading, but was calculated from the curves which now were smooth and sharp. The maximum error is estimated at less than 1/10-pound at 21 inches—about 1/60 of its original value. This error only amounts to 1/50 per cent of the maximum scale reading of 500 pounds, and this sensitivity has not changed noticeably in more than a year.

Quality
IN THE PRICE CLASS

The demand today is not for price or quality alone *but for quality at a price* ... The model E E and E E X motors illustrated meet this exacting requirement .... These motors are built to the well-known Dumore quality standards. They develop 1/75th H. P. and are of the universal type with balanced armatures. They are enclosed in a tightly-fitting die cast housing and are equipped with self aligning bearings in addition to possessing other typical Dumore quality features ... Investigate the application possibilities of these two models! .... Send us a print of your requirements. The Dumore engineering staff may be of assistance to you in the application of either of these two Dumore models to your product.

Send for bulletins which fully describe the Dumore Double Gear Reduction Units. These bulletins contain complete technical data regarding reductions, shaft speeds, dimensions and etc.

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MOTORS

BUSINESS AND SALES BRIEFS

ELECTRIC Motor Corp., recently was organized at Racine, Wis., for the purpose of manufacturing fractional horsepower universal motors. Officers of the company are I. H. Dunham, president; R. H. Kellogg, vice president; and H. S. Wagoner, secretary and treasurer. Principal offices and factory are located at 401 Lake avenue, Racine, Wis.

* * *

I. L. Jennings is now director of sales of Lamson & Sessions Co., Cleveland, bolt and nut manufacturer, succeeding C. H. Longfield who resigned recently.

* * *

Plykrome Corp. has moved its offices from the Transportation building to 1 Wall street, New York, room 1702.

* * *

William Giles Newton has opened an office as consulting engineer specializing in die castings and die casting equipment at 151 Court street, New Haven, Conn.

* * *

Cole Automatic Nut-Lock Corp., Elwood, Ind., has appointed Ohio Equipment Co., 5716 Euclid avenue, Cleveland, as sole distributors of its lock nuts.

* * *

Machinery & Welder Corp., formerly at 2604 North Cicero avenue, Chicago, moved recently to new and larger quarters at 316 North Sheldon street, Chicago.

* * *

J. Edward Daily, formerly a vice president of the Timken Roller Bearing Co., Canton, Ohio, has been named general manager of the Steubenville works of the Wheeling Steel Corp.

* * *

Baldwin Locomotive Works, Philadelphia, and subsidiary companies are the most recent organizations to be licensed by Dardelet Threadlock Corp., New York, to manufacture bolts, nuts and other parts threaded with self-locking thread.

* * *

Fred C. Archer has been appointed as manager of the Philadelphia district by Lincoln Electric Co. with offices at 401 North Broad street, Philadelphia. This office maintains a sales and service organization for all products of the Lincoln company.

* * *

Barbour Stockwell Co., Cambridge, Mass., is now selling in the New England territory the complete line of silent and roller chains and sprockets manufactured by Whitney Mfg. Co., Hartford, Conn. Roller chain will be carried in stock at Cambridge, Mass.

* * *

Marlin-Rockwell Corp., Jamestown, N. Y., has consolidated the sales activities of its subsidiaries, Gurney Ball Bearing division, Jamestown, N. Y.; Standard Steel & Bearings Inc., Plainville, Conn.; Strom Bearings Co., Chicago. The bearings manufactured by all of the companies will be available through the executive and general offices at 402 Chandler street, Jamestown, N. Y., eastern district sales office at Plainville, Conn., and western district sales office at 2526 South Michigan boulevard, Chicago. Branch sales offices will be continued at their former addresses in Detroit, Cincinnati, Cleveland, Los Angeles and San Francisco. A new branch sales office has been opened at 40 West Sixty-third street, New York.

BALANCE

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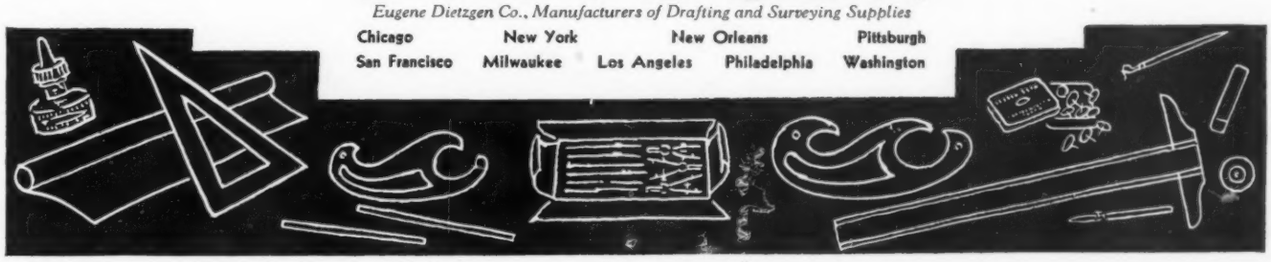
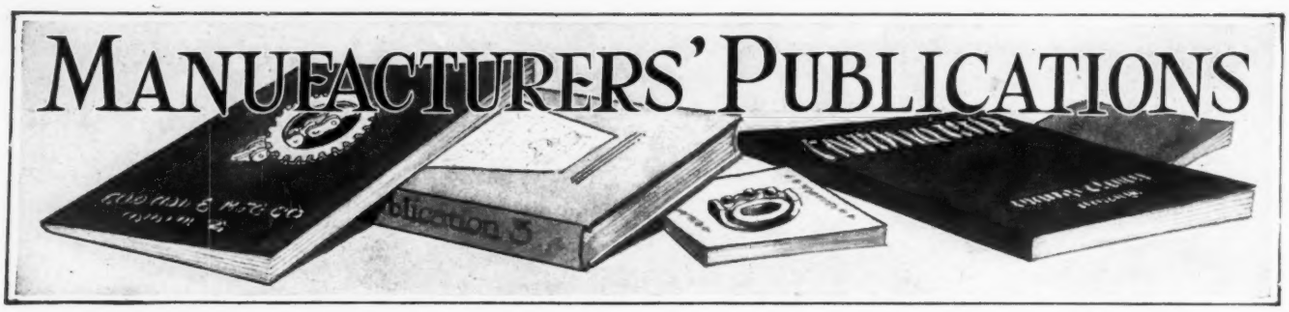


MANUFACTURERS' PUBLICATIONS



Publications listed in this section may be obtained by engineers responsible for design from the manufacturers of the products or through MACHINE DESIGN

ALLOY (STEEL)—Crucible Steel Co. of America, New York, has issued a bulletin on its line of stainless steels. Uses presented pictorially include equipment in the dairy, culinary and institutional fields.

BEARINGS—Engineering information on sheave mounting is included in application sheet No. 201 FE issued by New Departure Mfg. Co., Bristol, Conn. The sheet considers the problems presented and how they may be overcome. Mountings for mine car wheels are covered in No. 200 FE.

BEARINGS—Fafnir Bearing Co., new Britain, Conn., has published the sixth edition of its engineering data book. The book, brought up to date in all respects, embodies all dimension and design details of internationally standardized ball bearings as well as many special types. Applications are covered completely.

CAST PARTS—New Jersey Zinc Co., New York, has prepared an attractive engineering booklet on Horse Head Zinc for Die Castings. Charts and a table on the effect of aging treatments on tensile strength, impact strength and dimensions of the alloys are presented for the first time. Other topics discussed are heat treatment for stabilizing the dimensions and properties of the castings, machining, inserts and finishing. Excellent photographs show the types of die castings which may be secured.

CLUTCHES—Engineer's Specialty Co., Chicago, has prepared a booklet on the Columbia One-Way Clutch Coupling which is designed as a free wheeling unit for industrial equipment. Action is obtained by motion of eccentric cams which grip an enclosing case as it turns, and revolve the driven shaft. When the driven shaft rotates faster than the driving shaft the cams allow the case to slip past freely.

DRIVES—Constant tension drives for application to any process requiring a constant tension in material being wound upon or unwound from a reel are presented in bulletin 602 of Reliance Electric & Engineering Co., Cleveland. The bulletin describes the equipment and gives engineering information on the principle used.

DRIVES—Link Belt Co., Indianapolis, has prepared a 144-page catalog on steel chains in which information on the older chains is brought up to date and many new and useful sizes are offered for the first time. The sizes range from the small detachable chain having an ultimate strength of 950 pounds to powerful chains of as great strength as 1,500,000 pounds. The book is No. 1192.

DRIVES—Variable speed motor pulleys and countershaft units are presented in Catalog V-200, prepared especially for the information and reference of machine designers and manufacturers by Reeves Pulley Co., Columbus, Ind. The catalog gives complete engineering information on the units and applications and engineering tables. The principle employed in the drives is described and the formulas used are explained.

DRIVES—Dayton Rubber Mfg. Co., Dayton, O., is issuing a new industrial catalog on its cog-belt drives known as No. 105 Condensed. This publication, which includes all data pertinent to the selection of V-belt drives, has been made compact for ease of filing and inclusion in binders. Engineering information and formulas are given, as well as descriptions and photographs of installations.

FASTENINGS—Automatic lock nuts which do not require special tools for their operation are covered in a pamphlet distributed by Ohio Equipment Co. Inc., Cleveland.

GEARS—Engineering data on large hypoid and spiral bevel gears is included in Form No. 600 issued by Gleason Works, Rochester, N. Y. The 24-page booklet contains complete information on the design, application, efficiency, speeds and horsepower transmission of these two types of bevel gears besides standard specifications from which the engineer can select gears suitable for specification.

MOTORS—Midget motors which have maximum output of from 0.00035 to 0.0060 horsepower depending on the type are described in a series of data sheets published by Barber-Colman Co., Rockford, Ill. The sheets cover two-pole reversing, two-pole geared head, four-pole unidirectional and two-pole unidirectional types and general information on shaded pole motors.

PACKING GLANDS AND PACKING—Garlock Packing Co., Palmyra, N. Y., is distributing Catalog B, a well-prepared 157-page book which covers packing manufactured by the company. This attractive and comprehensive publication includes information on the application and care of packings, selection and general recommendations in addition to photographs, descriptions and specifications of over one hundred types of metallic and composition packing for a large number of uses.

RUBBER—Hard rubber products for industrial purposes are presented in catalog No. 1 of the American Hard Rubber Co., New York. The publication includes physical, chemical and electrical properties of the material and describes molded and fabricated parts made from hard rubber.

STEEL PRODUCTS—Jones & Laughlin Steel Corp., Pittsburgh, is distributing a booklet on the products made

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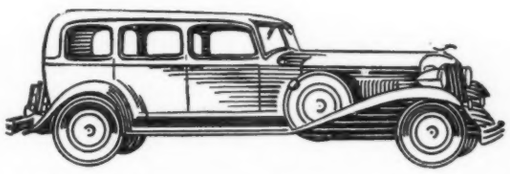

■ If your product must be made lighter without a sacrifice of strength, one solution is to replace ordinary steel with alloy steel parts. Before you write your specifications, however, supplement your knowledge of alloy steels with the vast fund of practical information that Electromet Service offers you without charge. As the pioneer producer of ferro-alloys and metals for steel-makers, Electromet has accumulated a body of data which, applied to your problems, will insure utmost economy in design and maximum satisfaction in performance. To realize maximum return on your investment in alloy steels, utilize Electromet Service. A request on your letterhead will bring you complete information.

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by the company and their uses. The publication covers Jalcase steel, screw steels, shafting, rolled flats, tin plate, spring wire, cold heading wire and others.

WELDED PARTS AND EQUIPMENT—Linde Air Products Co., New York, has brought out a 20-page booklet describing the physical and welding properties of its new bronze welding rod. Applications are described in joining metals and building-up wearing surfaces.

Research Publications

Physical Properties of Heat Treated Cast Iron, by F. G. Sefing and M. F. Surls. Results of exhaustive investigation on the effect of various types of heat treatment on the physical properties of cast iron. The bulletin includes a description of the tests and results, microphotographs and charts. Published as Bulletin No. 47 by Michigan State college, East Lansing, Mich. 33 pp.

The Mechanical Harvesting of Cotton, by H. P. Smith, D. Scoates, et al. A report on a five year study of mechanical cotton pickers, including the types developed, conditions encountered, theories employed and a listing of patents granted on cotton picking machines and movements. Published as bulletin No. 452, by Agricultural and Mechanical College of Texas, College Station, Tex. 72 pp.

Standards Yearbook, 1932. This book includes summaries of important national and international standardization activities and accomplishments of the government standardizing laboratories of England, France, Germany, Canada, Japan and United States. Standardization activities of American technical societies and trade associations also are covered. Available through Superintendent of Documents, Government Printing Office, Washington. $1.

Determination of Stress Concentration in Screw Threads by the Photoelastic Method, by Stanley G. Hall. The results of a study involving the determination of stress in a transparent specimen by passing plane-polarized light through the specimen and measuring the phase difference of the two emerging light vibrations by means of a Babinet compensator which consists of two quartz wedges; the movement of one of these wedges necessary to bring a dark line back into position under the cross engraved on the other wedge is a measure of the difference in principal stresses in the specimen at the point where the light passes through. The results of the tests show a stress in the American Standard thread about 40 per cent greater than that in the Whitworth thread. Regardless of the size of the threads tested, this ratio of stresses was nearly constant for the two different thread forms. Issued as bulletin No. 245 by Engineering Experiment station, University of Illinois, Urbana, Ill. 17 pp. Free.

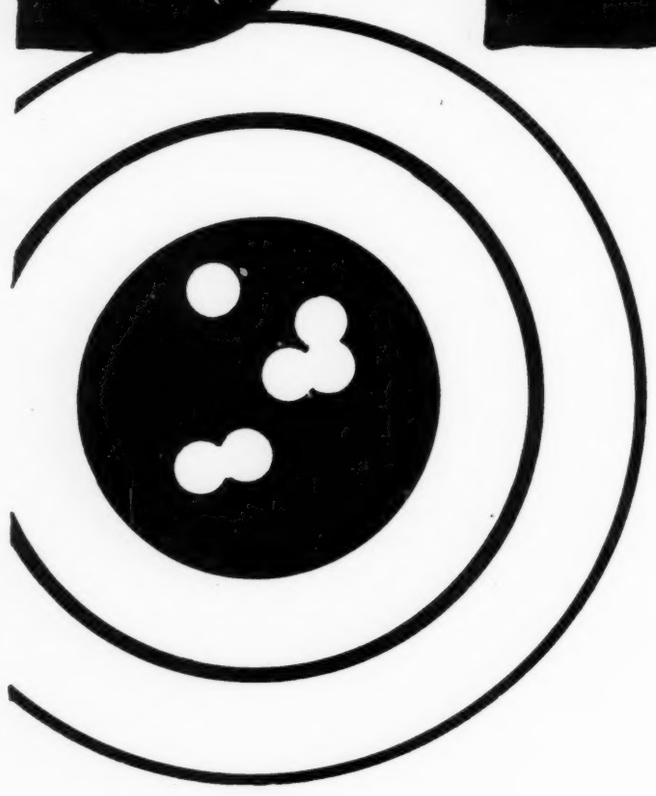
Itemized Index, December, 1932

Key: Edit, Editorial Pages; Adv, Advertising Pages; R, Right hand column; L, Left hand column

Compiled for the assistance of engineers confronted with specific design problems

WHEN a manufacturer of printing presses brings out a new design—one in which the designer has departed from existing practice—it is certain that the new press embodies features of interest not only to other manufacturers of printing presses, but also to builders of washing machines, packaging machines and scores of other types . . . The reason for this is that similar basic principles, materials and parts are used—all machines being fundamentally the same . . . MACHINE DESIGN serves the engineer in charge of design by describing—as one of its primary functions—the features embodied in specific and up-to-date machines—selecting those features of common interest which may be considered for application in the design of other types of machinery.

DEFI



WHAT IS A MACHINE?

Expressed in its simplest terms, a device for applying or modifying force to a specific purpose is a machine. A few simple laws of mechanics are the basis for every machine built. All machines are made up of the same basic materials, incorporate the same basic parts. Hence there is a common interest between men who design machines, no matter for what purpose.

WHAT IS DESIGN?

The design of machines connotes the practical application of the mechanics of machinery, the drawing of plans, and the consideration of design on sales, as well. And, above all, it implies a thorough knowledge of materials and parts, and particularly close familiarity with the sources from which they can be obtained.

MACHINE

MACHINE DESIGN

THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO

December, 1932 Vol. 4—No. 12

Considering Design from the Production Standpoint

By Harold F. Shepherd

Part I—Founding

TOO often the engineer designs his parts without due consideration of production. With this article, MACHINE DESIGN begins a series planned to remind designers of methods to reduce costs and produce better designs by more careful consideration of manufacturing facilities and their application.

DESPITE the fact that in founding the designer has available a technique so flexible that it can be employed to produce anything from a sash weight to an equestrian statue, superior craftsmanship in pattern shop and foundry should be called upon even more sparingly than in the machine shop. However, the engineer who designs a new machine rarely tries to visualize the difficulties involved in the production of his design by the patternmaker and founder.

This is a machine age even for the patternmaker. He, like the machinist, wishes to employ machine work in preference to hand work and such work is considerably cheaper. Consequently, if patterns are to be built at a minimum cost castings must be designed for machine pattern work just as they are designed for machine finishing. Patterns to designs evolved from this practical viewpoint usually are adapted better to foundry production than those of more imaginative form.

Fig. 1 shows an example of this studied simplicity. Except for the filleting and finishing and the separate pads, this pattern was built up of machine cut scantlings, cants and staves.

Not all castings serve such few and direct functions as an engine bed. Fig. 4 shows a cast steel diesel - electric locomotive frame with provisions for engines, generators, draw bars, trucks, brake equipment; in fact the backbone of a locomotive. Because it would require a great many cores, however cast, this class of work is made by a special technique evolved by the foundry that produces it. A simple mold is swept out to receive the numerous cores which themselves confine the molten metal to the shape of the casting. Strict-

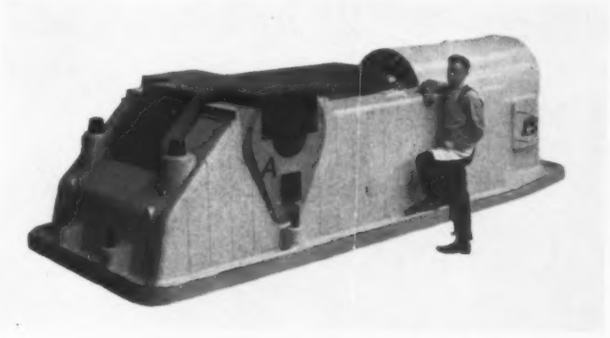


Fig. 1—Parts designed for simplicity of line permit patterns of machine cut scantlings, cants and staves

ly speaking, the mold proper is one great core print.

But castings cannot be designed from the patternmaking angle alone. While a good molder will produce a casting from any pattern that can be removed from the sand by some less drastic process than burning out, or make mold and cores with a few simple sweeps and forms, most production founding must be carried out with the aid of a large percentage of semi-skilled labor. Even when artisans are employed, the finest and cheapest castings are produced from designs which give evidence of being formed not only for function but for foundry production.

Should Recognize Parting Lines

Every normal pattern is constructed for draft from a conventional two part mold and every designer should be able to scan his drawing and recognize the natural or possible parting lines of pattern, mold and core boxes.

This much established, overhang and back draft may be detected and corrected wherever possible. Openings, serving to locate and support cores as well as to give vent to the gases liberated when pouring, may be placed in proper relation to the mold joint, with due consideration of the necessity for removing the reinforcing wires, rods and arbors along with the core sand when cleaning the finished casting.

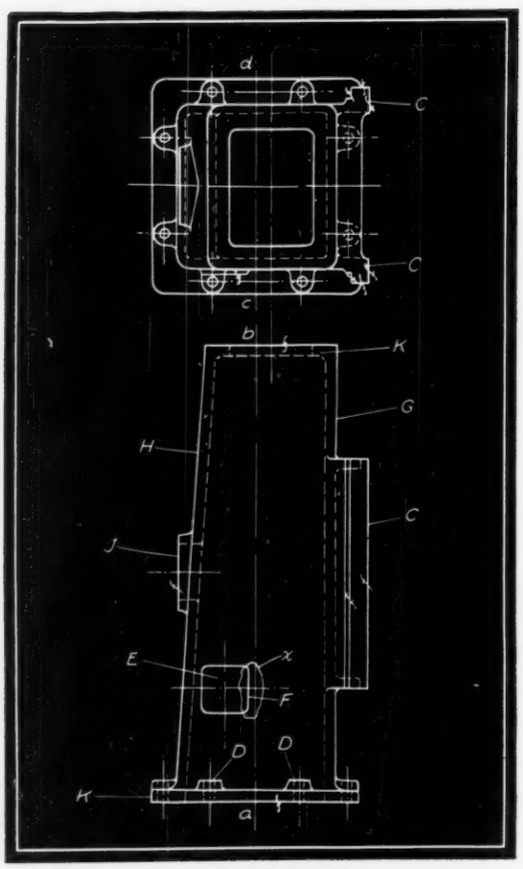


Fig. 2—Typical machine column design discloses points where production could be made easier

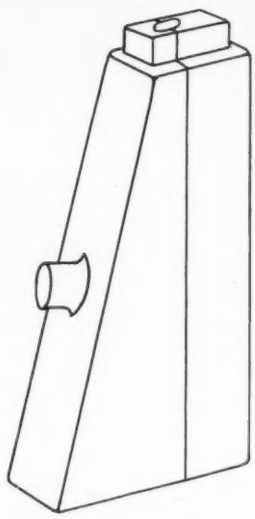


Fig. 3—When difficulty is encountered in visualizing the core required for a design it is wise to sketch it roughly. This sketch is of the core which would be required for the casting shown in Fig. 2

Fig. 2 shows a machine column serving as a specific example of some of the objections that may be offered to a design by the patternmaker if not foreseen by the engineer in charge. This column conforms in general appearance to common practice, yet much can be done to improve it from the production viewpoint. Although it might be produced otherwise the average foundryman would prefer to cast it on the side with the ways *C* at the bottom of the mold to insure a dense clean surface after finishing. The pattern would be split along the plane in which lie lines *ab* and *cd*. The first foundry operation is indicated in section by Fig. 5. The lower half of the pattern is inverted on a follow board with the drag half of the flask surrounding it. Sand will be rammed about the half pattern until the flask is filled. Next the sand surface is struck off, the bottom board bedded and clamped on and the job rolled over to receive the other half of the pattern and the cope or top section of the flask for final ramming up.

These operations completed, the upper half of the flask is lifted off and inverted. Both halves of the pattern are drawn, gates for the admission of molten iron are cut, and the mold dried and finished with a suitable coating. Finally, the cores are set and the mold is closed, clamped and weighted for pouring.

Ways Prevent Drawing of Pattern

Checking the effect of this design on the founding in more detail, Fig. 5 shows that the ways *C* protrude so as to prevent drawing of the pattern. These parts may be made loose and skewered or dovetailed in place so as to remain behind when the pattern is drawn, after which they can be drawn laterally into the mold. The pad *A*, Fig. 1, is dovetailed in this way while the pad *B* is skewered.

An argument against loose lateral projections

on a pattern which the designer should bear in mind, is that the tucking and bedding of pattern parts, once practiced, are not permissible in modern machine foundry practice.

The flask and pattern is set on the platen of a jolter or jarring machine. Sand is shoveled in or delivered from a chute, and the machine compacts it by raising the job and dropping it violently. Or sand is delivered to the flask in a penetrating shower by the centrifugal machine known as the sand slinger which rams by impact. Small or snap molds are rammed by hydraulic, pneumatic or lever presses if not by jolting the mold. These machines are used for a wide variety of work since in a measure they replace the care and judgment required for hand ramming the mold although some pean ramming about the draftless sides of common flasks still may be practiced.

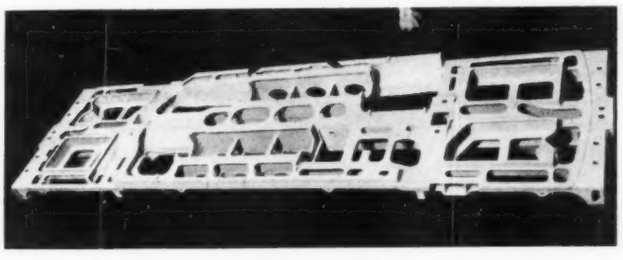


Fig. 4—A special technique is required to make many intricate castings such as this locomotive frame

Sand cannot be squeezed nor jarred compactly except in the line of motion, nor can it be flung from above to fill under overhanging ledges. Voids are left as in Fig. 5 at *N* unless what should be truly a machine process is supplemented by hand labor.

Scars Mark Fin Location

Cores as at *O*, Fig. 5, sometimes are used to overcome the difficulties introduced into machine molding by draft and overhang; but the result of this practice is a casting with two qualities of surface on the same plane, one showing the imprint of the core, the other that of the mold. The sands and washes used for the two are different, each being suitable to its purpose. Furthermore, scars are bound to mark the location of the fin due to molten iron finding its way into the junction between core and mold. Doubtless the ways, *C*, Fig. 2, could be brought within the main casting contour without impairing the machine, in fact the relation of length to breadth of saddle might be improved thereby.

There are other faults in this design of much the same nature. Lugs *D*, Fig. 2, will not draw except inwardly and must be made loose on the pattern unless backed up by a core print extending to the plane of parting. The side lugs could be omitted or, if required, a single bolt on the center line might serve as well. Pad *E* also will not draw except inwardly. If it may not be moved bodily so that its edge *F* coincides with the casting center line which is the mold parting line, it might be extended that far and the companion flange made to fit. If this is not done the little body of sand located in area *x* may carry away when closing or pouring and deposit somewhere else in the mold since it is only a bridge between pad and parting.

Halves May Not Register

Next, the core may be considered. It most likely will be made in two halves, the joint being along the plane *ab—cd*. If these two halves were symmetrical one half core box would serve for the job. Unfortunately they are not. Side *G* is plumb and side *H* slopes so the halves will not register when superimposed. If the column were made in parallel or obelisk form it would have the same cantilever strength and be a symmetrical core but for one other feature—the opening *J*. Openings could be made on both sides, serving several valuable purposes. Besides halving core box cost and storage bulk the core would be anchored against sag due to its own weight as well as against floating in molten iron or at least bowing under buoyant stress. Prints are always preferable to chaplets, especially for oil or pressure vessels where the latter so often introduce leaks. The pad about the opening notably provides aligned support for the machining operation on ways *C*.

Loose pieces in core boxes sometimes cannot be avoided by design changes. Coremaking usually involves attentive direction, and little machine work is possible in that branch of the industry. Much can be done, however, to simplify core boxes by redesign of the part, and if this is done consistently the making of cores on molding machines may be advanced. When difficult to visualize, it sometimes is wise to sketch

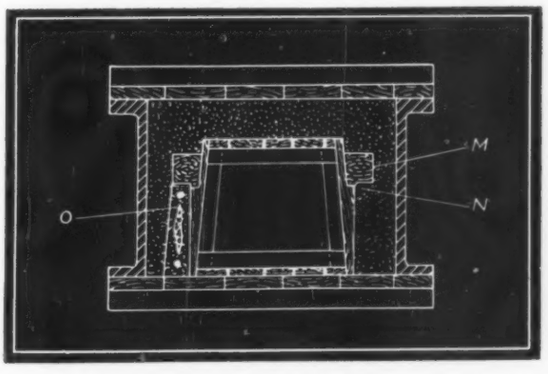


Fig. 5—Cross section of first foundry operation indicates points of difficulty in casting

the cores required for a casting as Fig. 3 serving for Fig. 2.

Frequently castings are better for the removal of a lot of internal stiffening since such ribs are prone to fracture by reason of late cooling while restrained by outer walls which have set previously.

The exact amount of shrinkage in a casting cannot be estimated accurately. Long castings frequently shrink much less than expected and as a consequence end flanges *K*, Fig. 2 carrying im-

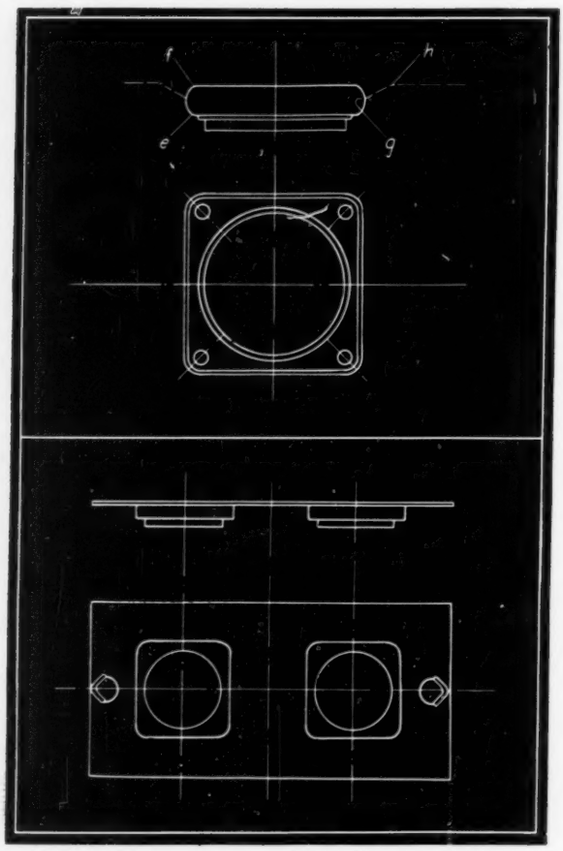


Fig. 6—The pleasing line shown in the top view increases cost while redesign, below, speeds production

portant stresses, show less than the drawing thickness when the casting is finished to the specified length. It is a good plan to dimension such flanges at least 1/16-inch to the foot of casting length thicker than actually required.

The height of pads also requires consideration. Molten iron standing in pouring heads, gates and risers exerts a terrific bursting stress on the flask and unless the heaviest type of flask equipment is used or the job rammed into the floor some strain takes place thickening casting walls. Thus the layout man may locate the machine dimension of a pad like *E*, Fig. 2 below the general surface of the casting. In this too common event the surface will require profiling out with a small milling cutter or unsightly chipping for planer tool clearance. Pads should be of ample elevation. If made of a height equal to the general casting thickness they should be about right.

The matching of casting pads and faces with the companion parts has a serious influence on the appearance of the finished product. Only the finest machine molded castings made from accurate metal patterns may be expected to match. In designing heavy machinery the accepted principle is to avoid the need of register.

When in doubt as to the "art value" of some line in a design a decision may be reached by considering what influence this line will have on the cost of patterns or castings. Thus Fig. 6 (top) is a cover plate for a pump valve. The line *ef* is pleasing, but when cast singly the mold must be jointly down as in *gh* by hand tooling and such partings are delicate and liable to leave irregular edges on the casting which will be ground off quite artlessly by the casting cleaner. If machine molded the metal pattern cost will be increased greatly by the necessity of mounting pattern parts accurately on both sides of the match plate and any slight shift in the mold when it is closed will result in offset castings.

Practical Considerations Are Best

Practical considerations are in best taste, particularly if ostensibly sound effects are liable to miscarry in process. Fig. 6 (Bottom) two patterns on a match plate, may look quite as well in place as the design at the top. It molds entirely in one-half of the flask, drag or cope as desired and if metal patterns are advisable they will locate entirely on one side of the match plate. No "shift" is possible and if intensive production is required this job, like all work with one plane side, may be cast in stacked checks, one above the other, the bottom of each mold serving as the top for the previous one. While opportunities to exercise judgment in these matters are daily before the designer he may fail occasionally to realize an advantage.

In heavy work, cored holes are advisable when they avoid a machine set up for an operation in which extreme accuracy is unimportant, as the foundation bolt holes in Fig. 1. They also are advisable when they tend to make cast sections more uniform and less liable to shrink cavities. Otherwise no burden should be put upon the foundry that may endanger the uniformly successful production of castings involving much labor or which may introduce the possibility of unexpected hand labor in assembly. Apparent savings in the machine shop by elimination of covers designed for core removal often result in no over-all gain due to the uncertainties and disorder of cleaning room operations as compared to the charted and timed machine tool operations which are so sure of uniform results.

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

Study the Home for New Markets

INDUSTRY'S new market lies in the modern home. With building activity falling behind normal requirements at the rate of 270,000 residences annually a tremendous potential outlet for millions of dollars worth of domestic machines and equipment is being created. It remains for American industry with its keen engineering brains, ability and foresight to meet the challenge and turn this source into a profitable consumer.

The steel industry already has made progress with its welded steel house covered with porcelain enamel shingles. Plans are under way in large cities for housing facilities on a large scale. To the designer all this means the development of fabricating machines in increased number and of modern type. His field, however, extends beyond that. With these modern homes must come more up-to-date household machinery. Equipment may be built into the walls as an integral part, on much the same plan as the built-in motor on a modern machine. The steel house lends itself more to this type of construction due to its increased strength and more substantial means of fastening.

Now is the time for the designer to show his ingenuity. Our modern mass production methods are capable of manufacturing economically; what we lack are more new ideas for products that will appeal to the public and which are within its reach.

Confining Power to Smaller Space

CONSERVATION of space should be one of the primary aims in design. When an important manufacturer in the automotive industry recently set out to build a motor bus with the greatest possible percentage of floor space available to passengers its engineers went to work on an engine of radical design. The result was a 12-cylinder horizontally opposed unit, Fig. 1, of such low overall height that it could be mounted below the floor.

The engine, transmission, clutch, etc. did not necessitate a kickup in the floor because of the study which had been given to installation requirements. A flywheel of small diameter is employed and the two carburetors are located under seats on opposite sides, with combustion air taken in through the sides of the body. Thus the layout of this power plant application gives unrestricted riding area for 44 seated passengers and 56 standees, a total of 100 passengers. The bus and engine were built by White Motor Co., Cleveland.

Crankcase of the engine is aluminum alloy with all main bearings secured by through bolts. Cylinder blocks are held to the crankcase by through bolts in addition to studs, but permit removal of cylinder blocks without disturbing main bearing adjustment. All main bearings are heavily ribbed, and all main oil delivery passages are drilled in the case. Special nickel chromium alloy cast iron was selected for the cylinders, with exhaust valve seats of the screwed-in type which already have made mileages in excess of 100,000 possible without re-

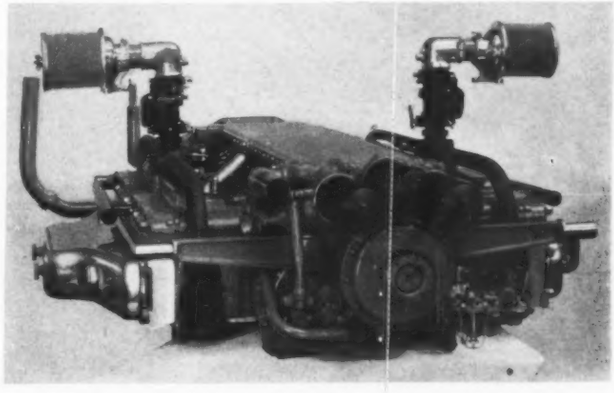


Fig. 1—Design of this engine with horizontal cylinders reduces overall height considerably. Horizontal type engines may be needed if rear-engined cars mature

grinding. Aluminum alloy is used also for the cylinder heads.

The pressure lubrication system is of the dry sump type so that cylinder lubrication is not affected by grades, and the oil sump which is built over the crankcase permits oil to leak from the sump through the oil pump to the crank-

case when the engine is standing long enough to get cold. The arrangement allows connecting rods to dip when the engine is first started, thus automatically giving excess lubrication to cylinders and pistons when starting cold. This desirable feature is important in prolonging the life of cylinder bores, pistons and rings, and at the same time minimizes crankcase dilution.

Propeller Design Balances Forces

PROBABLY no better stimulant for bringing out new ideas is to be found than designing a unit to meet requirements for which little precedent exists. That is what Gar Wood did when he developed MISS AMERICA X. One result was the use of a propeller, Fig. 2, embodying a new principle.

Fundamental differences between the blade of the new screw and that of the conventional type are in the working surface which has been re-aligned, and in the redistribution of weight. With this design, developed by Federal-Mogul Corp., Detroit, the bending strain resulting from centrifugal force actually is redirected in such a manner that its effect is in exactly the opposite direction to the thrust load.

The new principle lies wholly in the fact that the working surface of the blades is generated on something in the nature of a V-thread formation. Blade flexure always has been a problem in connection with high speed operation for although a blade may be able to withstand permanent distortion under its normal load there is tendency for it to flex in use within its elastic limits, particularly as it passes through the strut stream. This flexure causes momentary change of pitch which expresses itself in noticeable vibration. The new blade designed apparently resists this vibration to a far greater degree than the conventional type.

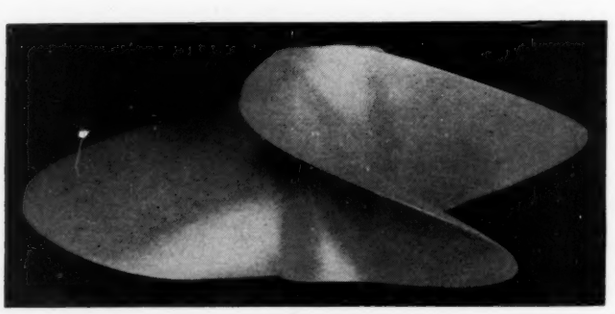


Fig. 2—Centrifugal force balances thrust load in the operation of a new type of speed boat propeller

Watch Electron Tube Progress!

COMPANION of the electric eye, the keen sense of sight of which has been the basis for hundreds of applications in design, electronic apparatus employing infra red rays promises to provide a sensitive means of feeling. When the Macneil thermo-electric sextant, employed to determine the position of the sun through thick clouds, was pointed out of the studio window during a recent demonstration, its sensitive thermocouple "felt" the heat from smokestacks six miles away.

Navigation, industrial applications, remote control and safety appliances all present striking opportunities for infra-red detection, *Electronics* says. Experiments now being conducted by Commander Macneil include the location of airplanes flying above the clouds at night by "feeling" the heat from their exhausts. An appreciation of the sensitivity incorporated in this instrument may be gained from the fact that it will detect the heat of a man's face at a mile's distance and that of a horse's at two miles.

In war a smokescreen no longer will be vital in protecting warships—their hot funnels betray them to the new device. Icebergs cease to be enemies of navigation, a recent demonstration disclosed. A cake of ice hidden behind a thick sheet of black rubber to simulate fog, with all lights in the studio turned out, was located instantly by the thermocouple which swung around the "horizon" and spotted the concealed "iceberg." With such progress in this development designers soon may have a medium of feeling as well as seeing by automatic means.

Sprayed Metal Offers Possibilities

SPRAYING of molten metal on surfaces of machine parts and equipment is being adopted by industry as an effective means of combating corrosion. The same process also is being employed to build up worn metal parts and may simulate the progress of welding. With a special spray gun any of the commercial metals obtainable in wire form may be applied in the molten condition and built up to any desired thickness.

In the operation of the gun the wire is fed over a flame which may be oxy-gas or oxyacetylene. The spray gun shown in Fig. 3 is employed in the process, owned by the Metallizing Co. of America, Los Angeles, and melts the wire by an oxyacetylene flame. Air pressure forces the molten spray out of the gun at a high velocity.

Mechanism of the gun may be divided into two essential parts, the wire feed mechanism and the gas head. A small 12-blade turbine in the rear part of the case is powered by air to drive the gears and a knurled feed roll which propels the wire through the gun. The top part of the case is hinged. A pressure plunger fitting over the idler shaft yoke is used to supply the necessary pressure to the yoke to engage the feed wire. Between the case and gas head body are the orifice plates for mixing and metering the gases. Smoothness of the coating is depend-

ent upon adjustment of the air cap that regulates the stream of air which completely surrounds the gas flame.

The bond between the two metals is made by force of impact on a thoroughly sand blasted surface, rather than by fusion of the two metals. A terrifice impact drives the atomized spray on to the metal on which it is applied. With a properly prepared base the coating becomes practically an integral part of the base material.

Conditions Must Be Studied

Designers specifying this process either as a protective coating or for building up parts need to watch that selection of the proper metals to be used, for any application embraces a thorough consideration of all the physical properties of a metal along with a study of the conditions under which it will be employed.

Sprayed metal is somewhat similar to cast iron and in many respects may be machined in the same manner, H. B. Rice, Metal Spray Co., Los Angeles, brought out in a discussion before the American Welding society. For example a sprayed bearing may easily be machined by taking fine cuts with a small round nose tool and finished with emery.

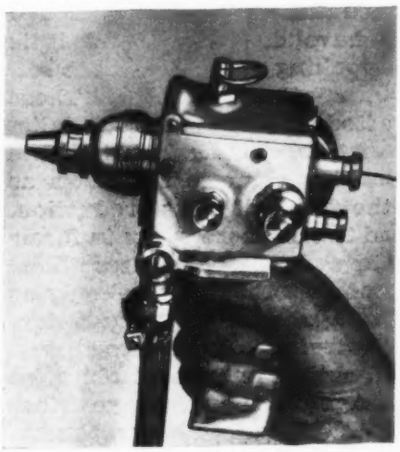


Fig. 3 — Typical metal spray gun employed in a relatively new process which is capable of providing a protective coating of one type of metal on a dissimilar material. Building up of machine parts is another field in which the process holds many possibilities

Press Embodies Multiple Rams

BECAUSE a unit is large it does not necessarily follow that the working parts are unrefined in development or construction. One example of exceptional design and workmanship is found in a recently developed steam platen press, Fig. 4, which has a maximum capacity of 20,000,000 pounds. Tested under working pressure, the greatest deflection anywhere in the platens did not exceed 0.004-inch.

Claimed to be the heaviest tonnage steam platen press ever built, engineers of the Lake Erie Engineering Corp., Buffalo, N. Y., designed the unit with twelve 18-inch rams. Steel construction is employed throughout with the exception of the semisteel rams. Columns are of special alloy steel showing an ultimate tensile strength of over 120,000 pounds.

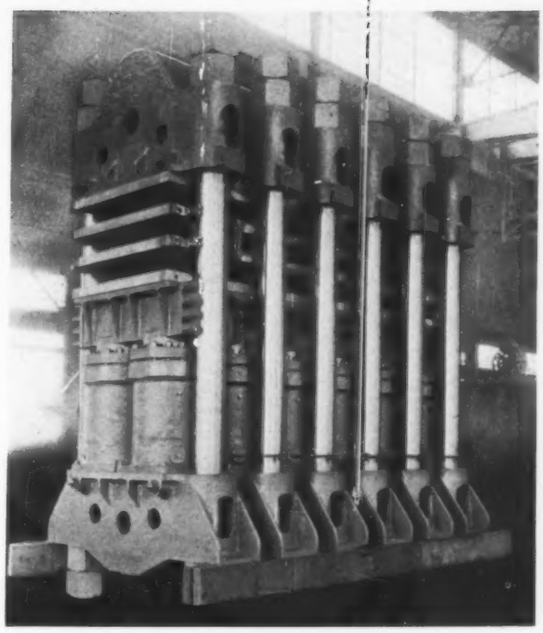


Fig. 4—Despite enormous capacity the platen deflection in this press does not exceed 0.004-inch

Centrifugal Force Augments Spring

CLUTCH practice is undergoing changes to keep up with modern trends. Recently it was announced by W. C. Lipe Inc., Syracuse, N. Y., that its engineering department has developed a new unit embodying unusual features. Twenty interlocked pressure levers are affected by centrifugal force to augment the clutch spring when the clutch is engaged and retard the action of the spring when disengaged. This is said to effect nonshock engagement and compensate automatically for loss of spring pressure resulting from wear on the facings.

Because the clutch spring has no direct contact with the pressure plate it is well insulated from the source of heat. Pressure from the spring is multiplied through the levers acting on the pressure plate and since these levers form a discordial plate the pressure is applied evenly; thus no deformation of the pressure plate occurs through lever action.

APPLICATION of the reversed refrigerating cycle as a heat pump (M. D. April, page 26) to heat the Southern California Edison building has been watched intensely by engineers. Now comes a statement from H. L. Doolittle, chief designing engineer of the company, to the effect that the installation was practical and economical last winter.

IT is not enough today to have a machine that is mechanically perfect. Appearance is exerting an increasing influence on final selection by the purchaser. Mr. Teague, who points out how this factor may be included in design, is consultant for Eastman Kodak Co., Thomas A. Edison Inc., Taylor Instrument Cos., Marmon Motor Car Co., and other industrial organizations.

Supplementing Mechanical Efficiency with

By Walter Dorwin Teague

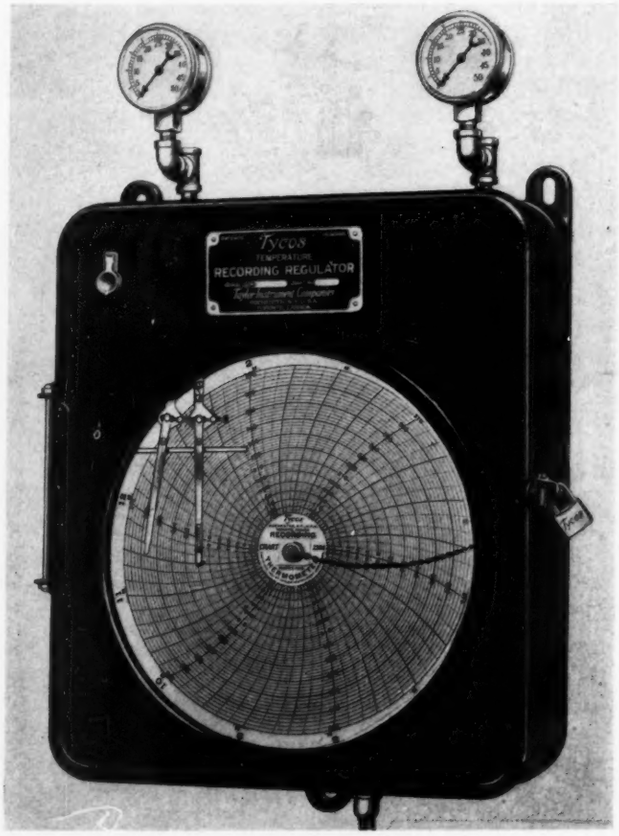


Fig. 1—Even purely utilitarian instruments offer many possibilities to the industrial designer for developing improved appearance without loss of efficiency

THE artist is a factor in industry today, but not through any initiative of his own; he has been dragged there by practical-minded business men who have discovered that it is easier to sell a good-looking machine than to sell the same thing in an unattractive guise. These executives have drafted the artist as a specialist in the appearance of things, and given him the job of injecting what has come to be known as "eye appeal" into the fruits of mass production. The artist is expected to cast these wares in forms which will stimulate a desire to possess them.

The artist—he prefers to be known simply as a designer—is thus a newcomer in industry, but the instinct he is serving is by no means new. It is, in fact, as old as human manufacture, as strong in the Stone Age or among savage tribes as it is today on Park avenue. Fine workmanship and good looks always have been inseparable. Appearance always has been an index of quality. The novelty in our present situation is our very recent discovery that this instinct cannot be neglected in the Machine Age any more than in the older periods of handicraft.

There is, of course, another new condition inherent in machine production. The technologies of today are enormously complicated, and no artist is competent to plan the technical side of modern production. On the other hand, I doubt if many engineers have the equipment which an experienced industrial designer can bring to the problem of external appearance—his trained sense of design, his knowledge of style trends, his invention rendered more fertile by practice in many diverse industries. It follows, then, that the two must work together. They must travel in double harness and each pull his share of the load if our machines are to be as good looking and as satisfying as they are efficient.

Also, if the results are to be really satisfactory, these two must work together from the very

th Good Appearance

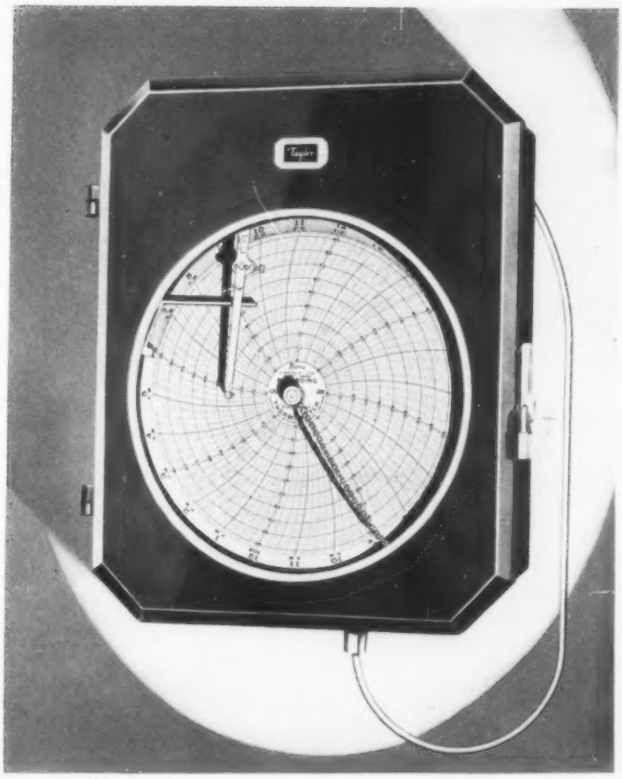


Fig. 3—Improved lines reveal quality and indicate attention to all details. This is a redesign of Fig. 1 as made by the author

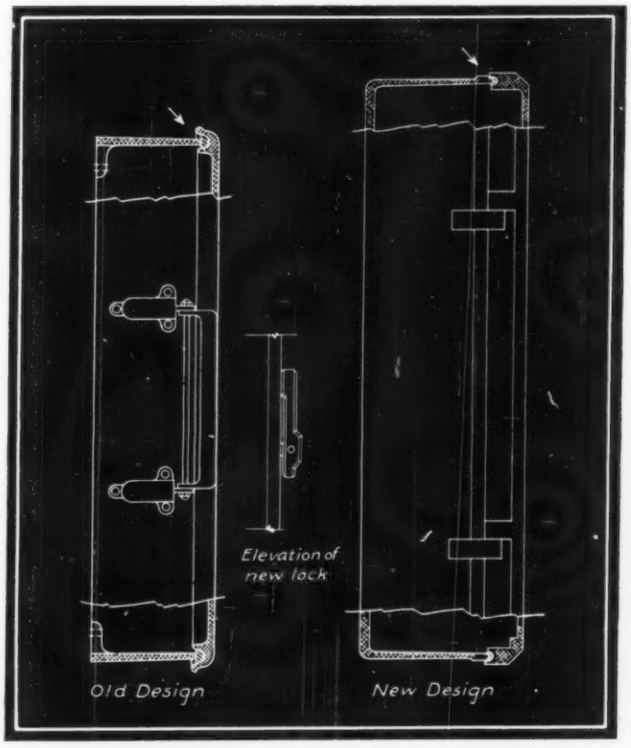


Fig. 2—New design brings the lid into closer relationship with the case and gives an appearance of better fit

inception of a product. Whatever you want to call this quality we are asked to get into our work—good looks, style, eye appeal, beauty—it is not something you can smear over a finished product like a coat of paint. It must be built in from the start. It is just as fundamental as good looks in a woman; she may be able to do a lot with rouge and lipstick but she never will be a real beauty unless her features are rightly proportioned, her bones and muscles sound, and her complexion and color good.

In the same way good looks in a manufactured article must be the result of sound construction clearly revealed; well organized relationships between elements so that a unified whole results rather than an assembly of unrelated parts; fine lines, fine proportions, fine surfaces; above all, that look of skilled workmanship and high efficiency which in a machine corresponds to the look of health and vigor in an athlete.

Practically everyone responds immediately to these attributes. Look at the dazzled crowds which gather around those beautiful stripped chassis and motors exhibited at the automobile shows, or observe the awe with which people crane their necks at the AKRON sailing overhead. This kind of response has nothing consciously to do with art, but it is to my mind a far more important evidence of artistic appreciation than the frequenting of picture galleries or grand opera. And it has a direct influence on the sales of merchandise.

It is the industrial designer's business to satisfy this love of finely-made, well-organized, beautifully-functioning products. This kind of work cannot be done in his studio or at his drawing board. It must be accomplished in the factory and in an engineering department, and it must be done in close co-operation with the men responsible for the design and production of the mechanism. An industrial designer passes from one problem to another, for he may work alternately on kitchen ranges, gas furnaces, cameras, washing machines, clocks, automobiles, glass-

ware, lamps, radios, or purely industrial machines. The principles of design are always the same, no matter where they are applied, and the designer specializes only in design from the

Fig. 4—Original cafeteria check register, although efficient, does not symbolize quality

organization and final appearance standpoint. On the technical side and the special requirements of a given problem he must, and does, rely entirely on the engineer in charge.

Perhaps it will be easier to explain what a design consultant does and how he works if we discuss specific problems, setting forth just how they were solved. Let us take, for instance, a case for recording temperature and pressure regulators manufactured by the Taylor Instrument Companies. This case as it formerly appeared and as it was redesigned is shown in Figs. 1 and 3. Here is a purely utilitarian instrument installed in power plants, engine rooms, dairies, etc. Perfect accuracy and dependability are, of course, its first requirements, but the manufacturers felt, and proved, that fine appearance in this type of instrument has a definite appeal to the engineers and executives responsible for its selection. They wanted the quality of the instrument to be revealed or symbolized in the design of its case. There was no question of "prettyfying" or decorating; it was plurely a question of *organizing* the lines, the surfaces and the necessary mechanical details into an impressive and satisfactory whole.

The case proper is in two parts, a box to contain the mechanism and a lid to close it. This mechanism must be easily accessible for setting and for the changing of charts, but it also must be locked against any tampering, and it is important that it be watertight. The two parts of the new case are die cast, and with the present advancement of the die casting art it is no longer necessary or desirable to break up the surface with beading or graining to conceal defects in the casting. Hence it was decided to make the castings perfectly smooth and to finish them with a rubbed black or white lacquer. Instead of rounding all angles with a large radius, the shape was reduced to a crisp and clean-cut arrangement of bevels. New and much simpler hinges were designed, together with a neater and more compact latch and lock. A narrow, chrome plated bezel was placed around the dial opening to relieve the severity of the black case. The large panel of lettering on the front of the case was removed to the interior and replaced by a small enameled name plate in silver with a touch of vermillion, adding a pleasant note of color. In all these details the main motive of octagonal forms and clean-cut bevels was carried out.

One of the principal problems in this product was its sealing against moisture. This is accomplished by inserting a band of sponge rubber

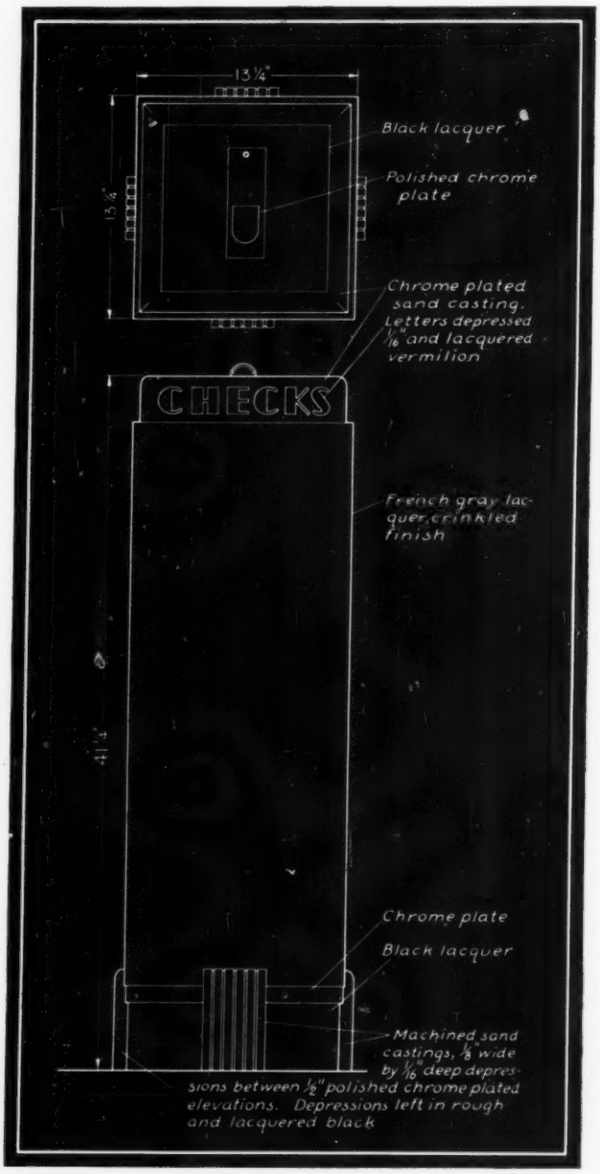


Fig. 5—Redesign for appearance can be carried out effectively without introducing complicated construction

in a groove cast in the lid, this sponge rubber being compressed over a flange on the box. In the old case the closure was so handled that the lid was much larger than the box and bore little relation to it. In the new case the overhang of the lid was reduced considerably and the box stepped-up to meet it. This slight ledge on the box near the lid has a practical value in deflecting water from the aperture.

Whether the new case is more "beautiful" than the old is a matter of no importance. The point is that the new case is organized much better. It has a look of fine workmanship, of high efficiency, of having been carefully thought out in every particular. The prospective buyer can see at a glance that the making of this instrument was so important to its manufacturer that he was willing to give careful consideration to every detail. It inspires confidence and respect, and the reception accorded it by its buying public proves that the effort was worthwhile.

Appearance May Retard Sales

Quite a different problem was afforded by the check register designed for the General Register Corp. This machine is used in cafeterias for the dispensing of checks. The customer withdraws a check or ticket from an aperture at the top and a bell is rung inside to attract the attention of the cashier. The old design, Fig. 4, had been in use for a number of years, and owners of smart and carefully furnished cafeterias had begun to manifest a reluctance to install this machine among their more up-to-date equipment.

On investigating the old housing it was found that some expensive processes were employed in its construction. In the first place, it was built of steel to imitate wood—a fundamentally false proceeding. To simulate wood construction it was assembled with projecting posts at the corners. These posts in the case proper were hollow angles to which sheet metal plates were spot welded. Below the case the angles were turned in and welded to form square legs. This was expensive as well as unsatisfactory because the welding of the corner strips for only part of their length set up a strain which caused them to "toe in" at the bottom, making it practically impossible to keep the legs truly straight.

As a climax the whole case was finished to imitate mahogany, and this type of finish costs much more than an ordinary lacquer such as is appropriate on metal surfaces. The admonition "Please Take Check Here" was lettered on a steel placard supported by two steel uprights at the back of the case.

In redesigning, we could not be satisfied with quite such classic severity as in the recording regulator case. The check register was to be seen and used by the general public and should

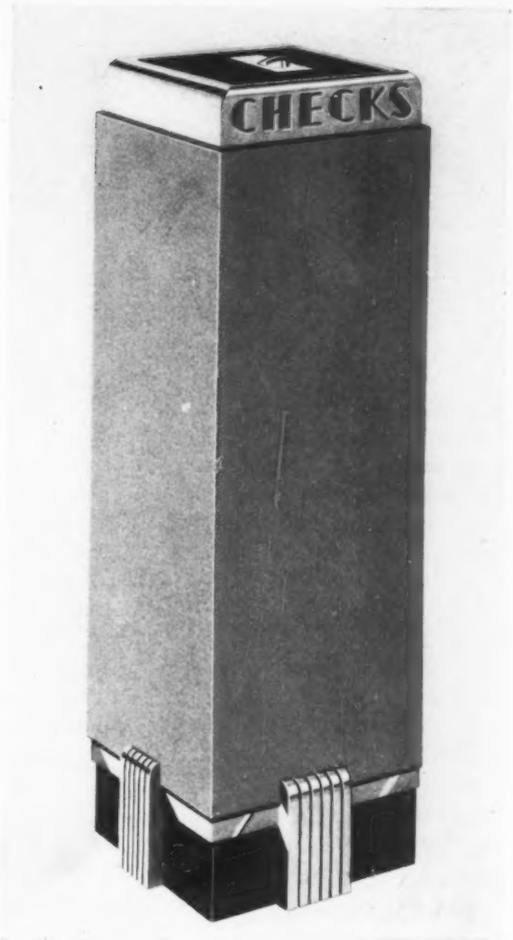


Fig. 6—Production advantages as well as improved impression are gained by restyling

be a decorative feature in any interior in which it was installed. This effect, however, was not to be obtained by elaborating it but, again, simply by *organizing* it into a well proportioned and attractive simplicity.

If a rectangular upright case is wanted, the obvious and easiest way to construct it is by forming a single sheet of steel into the shape required, Fig. 6. This was the first element in the design. For practical reasons it was not desirable to continue this case to the floor; some protection was needed at the bottom against the toes of customers and the mops and washing solutions of charwomen. Therefore inside the sheet metal case at the bottom was nested a band of chrome one inch wide, and inside this again a band of acid resisting black japanned metal four inches wide. To provide a more stable base and at the same time supply a decorative high-light, four cast and chrome plated supports were added in the middle of the sides. The housing was completed at the top with a chrome plated casting three inches high rounded with a curve similar to that on the bottom braces. This casting holds a black lacquered plate from

(Concluded on Page 68)

Stress Problems Are Discussed

INCREASED importance of more exact analytical determination of the stress in materials as affected by fatigue and creep, and the place of the engineer in activities leading toward the restoration of economic stability were topics given unusual prominence in the technical sessions of the American Society of Mechanical Engineers' annual meeting held recently at New York. Several speakers emphasized the point that considerably more research is needed in the determination of creep and fatigue stresses, and also that the importance of these two factors legislates against neglecting them when designing certain types of machines.

"Whenever machine parts are considered, the importance of localized failure, leading to a spreading crack under loads repeated hundreds of thousands of times, becomes vitally important, and the limitations of the mathematical theory, as applied to actual metals, becomes apparent," according to H. F. Moore. He continues, "For example, the mathematical theory of elasticity indicates that the localized stress at a notch, a screw thread, or a small hole depends not at all on the material, but only on the shape of the piece. Actually metals differ widely in the ratio between the load which, if often repeated, causes failure in a piece containing a notch or screw thread, and the load which will cause failure in a similar piece of the same metal in which the notch has been smoothed out or the screw thread turned out."

Need Additional Creep Data

Considering applications of creep tests, Gleason H. MacCullough, stated "In the general case of design, the most frequent problem facing engineers is that of designing a part for operation at a particular temperature of a material for which experience exists at lower temperatures. If the material is unaltered, it is usual to base design upon existing practice by reducing the ratio suggested by creep tests at the two temperatures."

N. N. Davidenkoff pointed out that "The yield point and tensile strength of a material under impact are always higher than those at low-speed tests, the yield point rising more rapidly than the strength. Working conditions of a material under impact are less favorable than those under static action of a force. As far as these two circumstances compensate each other, it is recommended that in calculations for impact the same allowable working stresses be used as for static conditions, employing the data obtained in static tests. (Neglecting, however, consideration of the reliability of the calculations.) The impact test for notched specimens can be used only as a check test, approving the use of a material or rejecting it; in determining the allowable stresses to employ, however, the results of such tests are of no value."

Machining Rate Higher

Discussions of materials did not concern themselves solely with stress distribution however. Enrique Touceda developed the point that "Malleable iron can be machined at a higher rate of speed for equal cuts than any other ferrous product of similar mechanical properties. That the castings are both fine grained and free from internal stress results from no effort on the part of the manufacturer to bring about such a fortunate condition, but is an accompaniment of the character of heat treatment that the hard iron castings must undergo in order that they can be converted successfully into the finished product. If the castings have to be welded, or if in service they are subjected to severe wear, they are being put to a use for which malleable castings are ill fitted."

Determination of product characteristics from the consumer's viewpoint was presented as one of the major management essentials for recovery by Carle M. Bigelow. This speaker emphasized the engineer's place in the recovery program and stated that the minimum volume that can be absorbed by economic distribution efforts should be determined and the manufacturer should organize to produce this volume.

A paper dealing with the determination of the number of active coils in helical springs by R. F. Vogt is abstracted in an article on page 37 of this issue of MACHINE DESIGN.

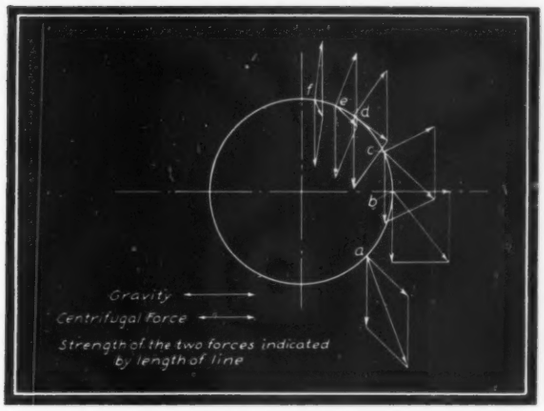


Fig. 1—Oil on the periphery of revolving wheel is subject to gravity and centrifugal force

By W. H. Himes

Splash Lubrication Fails at Subcritical Speed

CONSTRUCTION of enclosed gearing reasonably might seem to be an established art. Engineers who incorporate gears in design of their machines however, if not fully conversant with gearing problems, too frequently create mechanisms which for no apparent reason fail to function. There seems to be a widespread conviction, even among designers familiar with gearing, that almost any combinaton of wearing surfaces may be enclosed in a splash lubricated case with assurance that oil will find its way to all the surfaces that need it. Quite often this optimism is justified by results, but occasionally difficulty is encountered with resultant undue wear or complete failure in operation. In such cases the laws of nature have been violated. It is the object of this article to discuss some of these laws and their application.

First, a word about one of the errors of operating splash lubricated units, which still is too frequent—namely excess oiling. In spite of instruction tags and other educational measures taken by manufacturers, the impression is too prevalent among the rank and file of machinery users that an excessively high oil level can do no harm, and may be even an improvement. To what height should the oil stand in a splash lubricated case? The ideal height to provide for in the design of the enclosure is such that the gear that does the splashing should skim the surface sufficiently to secure efficient distribution, and no more. Any excess over this requirement will cause loss of power and excess heating due to the churning of the oil. It is not at all beyond the bounds of possibility to overheat in this way so much as to damage the bearings and other parts.

It is well to bear in mind in this connection that the temperature limit at which ball and roller bearings become susceptible to permanent injury is about 350 degrees Fahr. Several manufacturers give assurance that their bearings will operate continually at this temperature without damage. The results of the tests from which these data were obtainod do not indicate that exceeding this temperature will cause im-

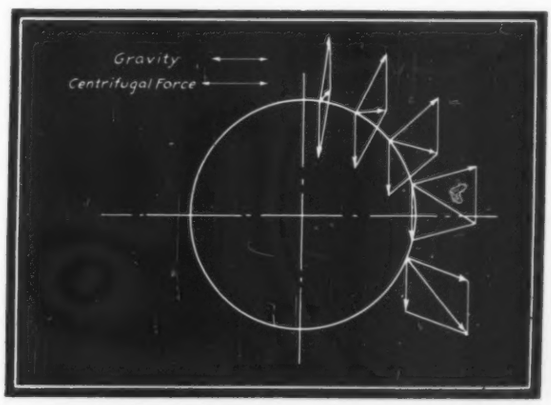


Fig. 2—When centrifugal force equals or exceeds gravity the vectors point away from the periphery

mediate failure, but rather that there is a perceptible softening of the steel beginning around that temperature. The exact degree at which such effect occurs depends, of course, upon the composition of the steel. In some cases bearings under certain load conditions would operate successfully even at 400 degrees Fahr. These excess temperatures would amount to "drawing" treatments of the steel and would result in no damage unless carried so far as to reduce the elastic limit to the region of the working stress.

How slowly can a gear run, and still splash effectively for lubricating? This is a question

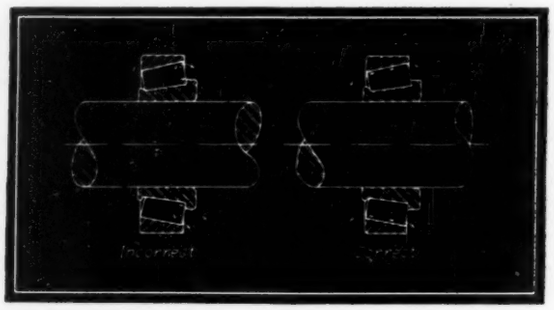


Fig. 3—Oil should be introduced at smaller end of roller bearings, as indicated by arrows

which the designer must face. A simple formula may be deduced for determining the critical speed where splashing ceases, in any given instance. It is evident that the oil on the periphery of a rotating wheel is subject to two forces —gravity and centrifugal force. In Fig. 1 gravity is assumed to be slightly stronger than centrifugal force. The effect of these two forces has been worked out at various points on the periphery by drawing the force parallelogram and finding the magnitude and direction of the resultant force. Thus at stations *a*, *b* and *c* the combined action of these forces is to overcome the adhesion of the oil to the gear and to pull it off.

The reader should note carefully that these vectors in no wise indicate the actual motion of the particles of oil after leaving the wheel, but a resultant force tending to separate it from the wheel. Once the drop is released it must start its trajectory in a direction tangential to the periphery at the point of separation. Obviously, the direction in which the drop flies depends upon the direction of rotation, whereas the vectors shown in Fig. 1 are unaffected by the direction of rotation.

At station *d* the vector is tangent and no result could be expected other than to cause flow along the periphery. At stations *e* and *f* the vector points inward, tending to draw the oil toward the interior of the wheel. Evidently then, no splashing effect can be expected from station *d* on up to the top of the wheel. The tendency begins at too low a point to guarantee successful lubrication. To insure satisfactory results the speed should be great enough to throw off oil, even at the topmost point. Viscosity enters into the problem to some extent, but apparently only to the point of varying the amount of oil thrown off, rather than affecting the critical speed. To attain the desired end the speed must be such that centrifugal force equals or exceeds gravity. Then the various resultant vectors will point away from the periphery of the gear, as shown in Fig. 2.

To this end let us consider the equation for centrifugal force in the popular form in which designers apply it.

$$F = .000341\, W\, R\, N^2 \qquad (1)$$

where F = centrifugal force, W = weight of object, R = radius of wheel and N = revolutions per minute.

Now as centrifugal force is to equal the weight, or the effect of gravity, for the critical condition, make $F = W$ in the equation, whereupon they cancel and disappear. The equation then becomes,

$$1 = .000341\, R\, N^2$$

or

$$N^2 = \frac{2935}{R} \qquad (2)$$

As either of the two terms N or R may be variable, we can solve for one with the other fixed.

Consider a case where a given unit has a splash wheel 1½ feet in diameter, and it is desired to know how slowly it may be run with

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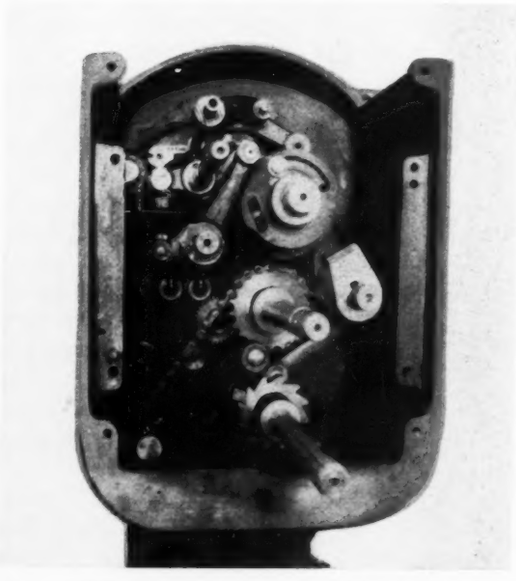


Fig. 4—Totally enclosed mechanism lubricated by splash method (covers removed). Oil flinger is driven by roller chain

Unitization— Logical Sequence to Interchangeability of Parts

By Arthur H. Adams

ALL matured complicated mechanisms tend to divide into units. Such units, however, rarely can be interchanged without adjustment, i.e., they are not strictly *interchangeable.*

Some interchangeability of parts long preceded strict limit gaging and true interchangeability in manufacturing practice, but real gains in interchangeability were not made until it became a procedure of design to set such limits and gaging standards on *all* parts as would produce a properly operative machine without selection or fitting in assembly.

Unitization is the extension of the 100 per cent interchangeability idea to functioning units, and means so designing any mechanism that it breaks into self-contained units, adjusted to *operating* as well as dimensional limits, such that a complete operative mechanism may be assembled of such units without selection or adjustment.

Assembly Savings Afforded

This principle makes great demands on the designer, but it leads to assembly savings comparable to those due to interchangeable parts. It frequently permits larger parts tolerances. It leads to surprising savings in stockkeeping. Repair work comes naturally into the factory because repair on unitized mechanisms consists of replacing units not parts, usually by the user. Investment in old product, now weighing on manufacturers, is lightened because the stockroom, the dealer, the user do not care how much or often your units *A, D* and *Q* are redesigned *internally.* Your model *T* may run on for years, and yet be ever new and up to date. Any desirable change can be made at any time, limited only by factory stock of parts for the unit affected, provided that 100 per cent interchangeability with old units is kept.

Before considering broadly modes of attack on the problems of unitization, there is a certain convenient terminology that conveys something of the technique. Most units have operating or force-transmitting relationships to others (frame units being sometimes an exception). These operating relationships being in the last analysis relations between positions of surfaces, one convenient distinction is between the two kinds of surfaces that must be controlled. One kind, the mounting, registering or stopping surfaces, determines the relative positions of co-operating unit frames. These surfaces may be called "mating" surfaces. One speaks of the "mating surfaces of unit *A* vs. unit *B.*" These may be mere machined surfaces on the frame of unit *A,* or a set of three bosses or adjustable stops, etc. Unit *A's* mating surfaces vs *B* necessarily will make contact on the mating surfaces of *B* vs *A.* In other words, *A* and *B* have "mutual" mating surfaces.

It does not follow that there are mutual mating surfaces between every pair of co-operating units. Units *C* and *D* may be held in mutual relationship by the relation of each to unit *E.* In that case *C* and *D* both have mating surfaces vs *E;* and *E* mating surfaces vs both C and D. The more particular the operative relation be-

UNITIZATION will be one of the watchwords of the future! The possibility of bringing out special models of machines or lines of new models without obsoleting previous designs is an ideal, yet it can be attained by combining interchangeable unitized mechanisms. Mr. Adams is consulting engineer, New York, member American Society of Mechanical Engineers, Fellow Royal Society of Arts, and Fellow American Association for Advancement of Science.

tween *A* and *B* the more reason for providing *A* and *B* with direct mutual mating surfaces.

Surfaces of a second kind, usually on moving parts, and ones by which motion is transmitted from one unit to another, are called "working" surfaces.

Surfaces Must Have Right Relation

One of the most basic items of the technique of unitization is that, in any two co-operating units *A* and *B*, *A's working* surfaces vs *B* always must be related to *A's mating* surfaces vs *B* (or, if the mating is indirect, to those mating surfaces of *A* that determine *A's* positional relation to *B*), and *B's working* surfaces vs *A* must be related to *B's mating* surfaces vs *A* by such dimensions and tolerances that a proper operating relation invariably results between *A's* and *B's* co-operating *working* surfaces regardless of interior changes in the unit. Moreover this relationship must be controlled in all vital positions, i.e. in all vital phases of an operating cycle.

In other words the relation, and the gaging of the relation, of a working surface of *A* to a co-operating one of *B* is broken up into two parts:

(a). the relation (in *A* alone) of this working surface of *A* to *A's* mating surfaces vs *B*.

(b). the relation (in *B* alone) of the right working surface of *B* to *B's* mating surfaces vs *A*

Let us fix these thoughts by a schematic example. In Fig. 1, assume that unit *A* contains a set of cams and cam followers the duty of which is to protrude and withdraw a group of rods *l* when any of the desired buttons 1, 2, 3, 4, 5 are depressed. Unit *C* is a one-revolution clutch transmitting to shaft *n* just one revolution each time start rod *m* of unit *A* is protruded (by the depression of a button) to press trip rod *t* of unit *C*. Push rods *l* operate tape punches *p* and thereby punch a five unit code of holes in a heavy paper tape fed through unit *B*. This tape may be for operating a giant electric typewriter. It will be understood that this is all a purely fictitious mechanism.

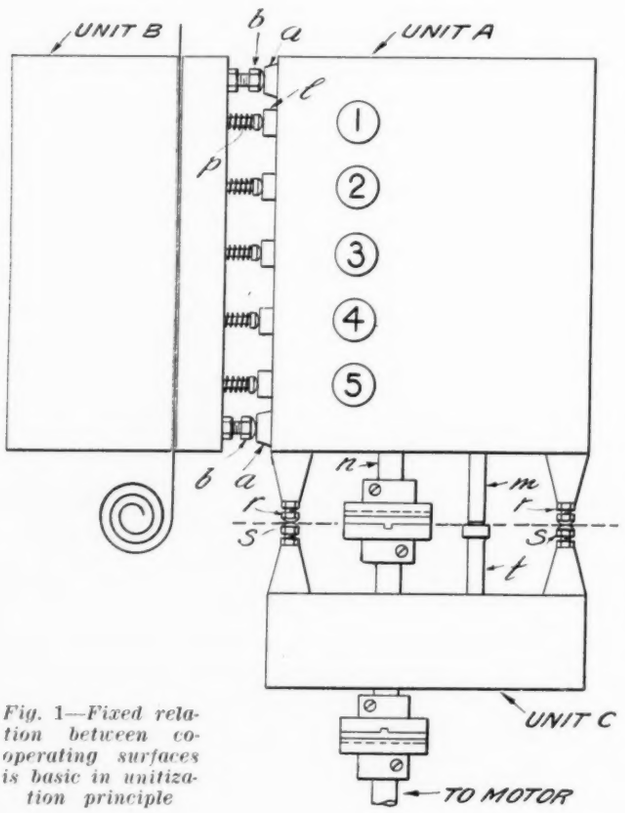


Fig. 1—Fixed relation between co-operating surfaces is basic in unitization principle

THE subject of unitization is so new and presents so many interesting problems, differing vastly in detail from one machine to another, that only outlines of the most broadly applicable principles can be given. In spite of general hints as to mental approaches, there is no substitute for ingenuity. Unitization may be a fertile and powerful method of original design as well as a principle of economical manufacture, and the results will be simpler and better mechanical movements.

Push rods *l* are shown retracted and in this position must permit punches *p* to withdraw completely into the stripper (see Fig. 2) and thus release the tape. They should not withdraw deeper than necessary, say 0.020-inch under flush, lest time be lost. The extended position of push rods *l* must force punches *p* inward far enough to enter the dies and perforate the tape but, to save wear, not a great deal farther. Let us say between 0.010 and 0.030-inch entrance.

In the detail view of the punch and die Fig. 2, these limits are shown, and the allowable stroke of the punch is indicated with its extended or operated position measured from the die surface, dimension *X*, and with its nonoperated position measured from the stripper surface, dimension *Z*. From these and the details is calculated dimension *Y*. These two operated and nonoperated position dimensions, *X* and *Y*, show severe requirements on the operated and nonoperated positions of push rods *l* in relation to the die face when the possible parts variations in unit *A* are also considered, and if the result were to be attained solely by close parts tolerances as in a nonunitized design.

It will be noted in the following how these conditions are eased materially by unitization. This simple example, primarily intended to illustrate the partition of working tolerances be-

tween two mating units, also serves to show the relaxation of parts tolerances that unitization often permits.

Stop screws *b*, Fig. 1, i.e. *B's* mating surfaces vs *A*, are adjusted to the gages shown: *GA*1, *GA*2, *GA*3 *and GA*4, Fig. 3.

There is high probability that among the five punches of one particular unit both extremes of length, 1.010 and 1.000 inch, will not exist. If this is true the tolerance of 0.012-inch between *GA*1 and *GA*2 is widened practically thereby. *GA*3 and *GA*4 are really checks on *GA*2 and *GA*1 respectively and on the 0.040-inch minimum 0.045-inch maximum paper clearance dimension. They might be omitted readily if this dimension and the punch length dimension are reliable. Clearly it normally will not be difficult to adjust unit *B* to these gages.

In unit *A* the stop bosses *a* might be adjustable stops like *b* but the conditions here favor a type of multiple surface alignment by machining

A DELICATE and intricate machine, manufactured in a number of models, was the subject of a complex 100 *per cent redesign directed by the author. The redesign was quite successful, realizing the advantages pointed out in the accompanying article, while a considerable part of the original tools were used. This intricate mechanism was operated and then disassembled in five minutes by use of a screwdriver to a couple of dozen simple units. Without adjustment and with only the screwdriver, it was reassembled in five minutes and again operated.*

that often is most convenient and economical in obtaining one of the working-surface-to-mating-surface relations. Assume that in unit *A*, with push rods *l* on the cam lows, i.e. fully retracted, the tops of push rods *l* and of bosses *a* are aligned as by a light grinding or milling cut. In some units the working surfaces might be machined stopping from the mating surfaces, or vice versa. In the case of unit *A* as shown, a good alignment of bosses *a* and push rods *l* is the only adjustment needed whatever the method used. This one adjustment eliminates all parts variations in *A*, i.e. it permits the tolerance to be very wide. It also is assumed that the *stroke* of push rods *l* in unit *A* can be held to minimum 0.067-inch, maximum 0.070-inch, to satisfy the punch-die and punch-stripper requirements.

The foregoing operative relation between units *A* and *B*, illustrating some of the primary ideas of unitization, is one of the simplest pos-

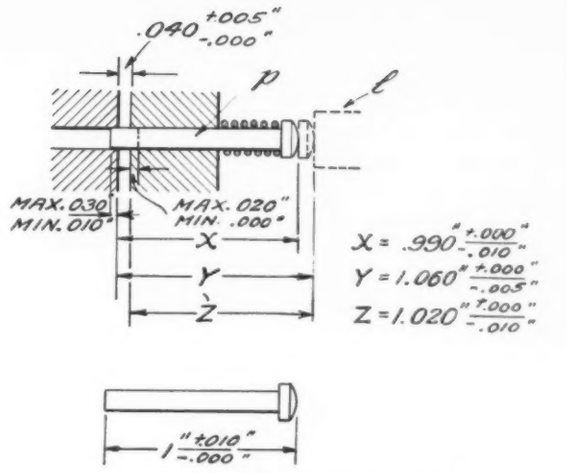


Fig. 2—Detail of working parts in stripper

sible. It involves only thrust and only two positions of the cycle at which relations need to be checked. The mutual mating surfaces of *A* and *B*, therefore, are required to have accurate position only along one axis. Torsions, up, side or down pressures, pulls, wedging, interference, and many other actions may exist in the operative relations between units. More complicated mating surface requirements may result. It often is necessary to position two units quite accurately relative to each other along two and sometimes three axes. The basic principle of holding to suitable limits, wholly *within* each unit, the relation of the working to the mating surfaces at various points of the cycle remains the same however complex that relation.

Two Working Relations Present

Fig. 1 illustrates other points. Thus unit *A* is shown with two different working relations to unit *C*, a rotary and a simple thrust relation. To set these relations satisfactorily one might adjust mating points *r* of unit *A* to align with the tip of start rod *m*. The coupling half on shaft *n* could also be set, for example, so that the face of the middle coupling member would align with points *r* as indicated by the dotted line. Then in unit *C* the mating points *s* would be aligned accurately to the end of trip rod *t*, and the other coupling half also aligned with them.

In many cases pressures, accelerations, frictions, inertias and other quantities may be involved, as well as positions and strokes, in the break up between units of functional or operative relations. For example, in unit *B* it might be necessary to consider the acceleration that the springs give to the punches *p* in order to be assured that the latter will follow back the push rods *l* without clatter. This simply means the springs must not be too weak. So far as unitization has been applied none of these quantities

has proved any more of a problem than in a nonunitized design.

The unitizing designer is forced, however, to analyze all mechanical actions rather more thoroughly than usual, especially as regards allowable tolerances of variation in stroke or timing. He usually will find that this close analysis shows the way to better operating margins, to much less exacting limits on parts, and to a set of operating tests (by units) individually and

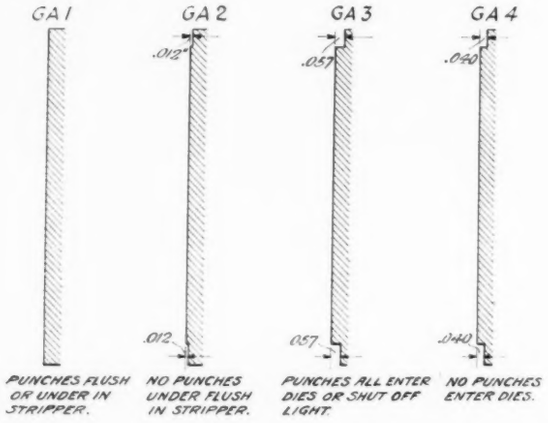


Fig. 3—Functional gages are used to control proper relation between parts

totally far simpler than the tests needed in the assembled mechanism to assure equally safe margins. Perhaps every designer of complex mechanisms has had the experience of discovering by peculiar sporadic failures how close to the margin of operativeness certain elements of a machine may be without the fact being detected by ordinary operating tests. The tests by units preclude any such concealed narrow margins.

The designer starting to unitize a machine as a rule will see his mechanism unconsciously in a few large natural units. After clearly visualizing these in their best relationship to each other, and perhaps refining this vision by making some schematic "unitized" drawings of each showing only general outlines, mating and working surfaces, the next step is to study one of these large units—say that one having the most contacts with the remainder of the machine (many and various working surfaces)—to see how best it may be unitized further. A fertile hint is to consider the mere causal relation between working surfaces. Consciously avoiding for the moment the vizualization of internal mechanism, consider which working surfaces of the big unit have something *done to them* and which ones, as a result, *do something*. The closeness or looseness of functional relation between the various "cause" surfaces and "effect" surfaces thus may be made more vivid, and some logical subdivision may emerge. The whole process is a functional rather than a physical analysis of mechanism. The object is the logical subdivision of mechanism by the work done.

Many simple units, easily assembled, adjusted and gaged functionally, rather than fewer more complex units, are best. Let more complex units, if possible, be assembled of simpler ones.

It will be obvious that gage design of a new order is required; functional or operative gages; accurate simulacra of units *B* and *C* to be used to test unit *A*. The best prototypes are to be found in the electrical industry where the most complicated mechanisms of the world—our power and communications systems—are the final physical product. Here a sort of unitization has been adopted unconsciously for sometime, and intricate operative gaging and testing methods for all kinds equipment, even whole circuits, have been developed. Pieces of electrical apparatus, though their mutual coaction is electrical rather than mechanical, may be regarded as interchangeable units of complex and complete operating mechanisms.

Functional Gaging Is a New Thought

The functional gaging of mechanically coacting units, with tolerances applied to *moving* surfaces and to mechanical forces and inertias is practically a new thought. A technique for limit gaging mechanical cperation, a technique that barely has been foreshadowed, is required for unitizing. There is infinite room for creative work. In many cases it is enough to gage certain positions of moving surfaces, within predetermined tolerances as in the example in the foregoing, sometimes at several phases of the mechanical cycle. Inertias and forces, once an operative design is made, rarely are involved in the functional gaging simply because they are reasonably constant in a given design. Friction adjustments are exceptions but they rarely create more difficult problems in unitized than in ordinary designs.

The most basic way to consider one of these gages for a unit is that it must represent an idealized mating unit, able to register from the mating surfaces of the unit and to coact with the working surfaces of the same to indicate whether their movements and positions are between desired limits at all necessary phases of the cycle.

To executives and designers now considering redesigns or new designs of complicated nature this new thought is recommended for earnest consideration. The constant need of improvement and the high cost of tooling for cheap production are in perpetual conflict in the live designer's mind. Setting aside direct savings, a well unitized mechanism can be redesigned, cheapened and improved for years, unit by unit.

Fig. 1—Convertibility of the unit from a shovel (upper left) to a dragline is a feature of design

Control of Motion Solved in Power Shovel

By J. D. Rauch

MODERN power shovels incorporate numerous moving parts which must be designed to carry out a variety of manually controlled functions without loss of time or energy. Moreover, the space in which the mechanism is confined is limited and therefore compactness becomes a major feature in the design. Inasmuch as four or five complete operating cycles often are performed per minute, each function must respond instantly to the operator's touch on the control levers. The shovel also should be so designed as to be convertible easily and quickly into other forms such as a dragline, clamshell, crane backdigger or pile driver.

Typical of a unit in which these details have been embodied is the new heavy duty power shovel, Fig. 2, built by Ohio Power Shovel Co., division of Lima Locomotive Works Inc., Lima,

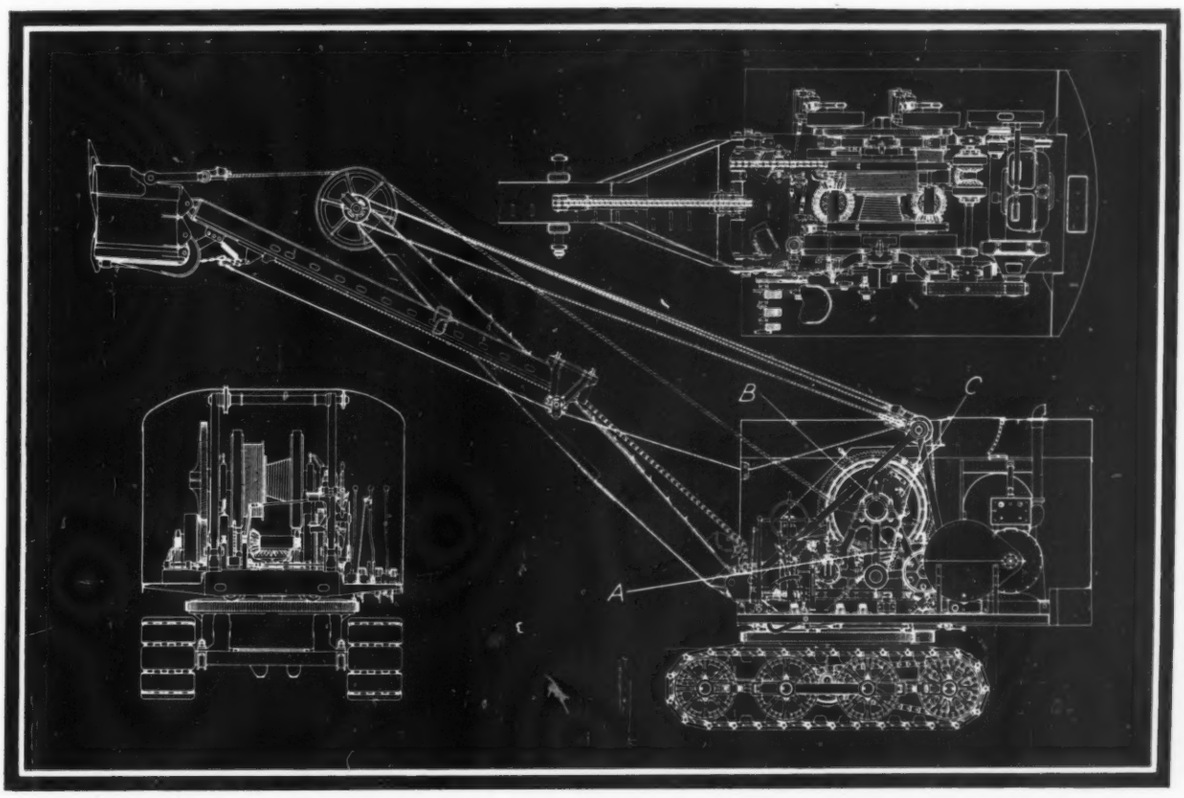


Fig. 2—Design details of this shovel reveal the degree of compactness which has been attained

O. Engineers engaged in creating machines for other types of work undoubtedly will be interested in some of the factors involved in the development of this shovel.

Cushioning effect in the various driving arrangements is obtained by the employment, on each of the four principal shafts, of two opposed clutches—the two on the forward shaft for use in traveling or crowding, two on the main shaft for operating the two drums, two on the rear shaft for swinging, and two on the jack shaft for raising and lowering the boom. All these clutches are of the internal expanding type.

Toggle Facilitates Ease of Control

Operation of the drum clutches, Fig. 4, is accomplished by power from the drive shaft through a small auxiliary brake. Arm *C* in Fig. 4 is drawn inwardly to expand the clutch band when the operator shifts the control lever to tighten the band *B* of the brake through the leverage shown in Fig. 3. The toggle *A*, Figs. 3 and 4, makes it unnecessary for the operator to hold the control lever to retain engagement.

Standardization has been one of the aims in the design of the shovel. Exemplary of this is the fact that the four swing, crowd and propel clutches are duplicates and are interchangeable. This also holds true for the two drum clutches as well as for the two boom clutches.

Employment of a single line hoist for the shovel offers many advantages over the two or three-part hoist customarily employed. Given sufficient engine power, its use eliminates the padlock sheave at the dipper and therefore permits a higher lift. Inasmuch as the speed of this cable is only half what it would be for a two-part hoist, the length of cable wound on the drum likewise is only half. This makes possible the use of a narrow drum, permitting the distance between shaft bearings to be materially lessened and affording more free room in the cab. The drum employed in connection with this single line hoist is tapered, providing for the greatest power when the dipper is digging and allowing speed to be gained when the dipper comes out of its work.

Large Drums Minimize Rope Wear

While large diameter drums always have been considered the ideal in shovel design, the difference in rope speeds necessary for convertibility from a dragline to a clamshell and vice versa more or less held designers to the use of small diameter high speed drums. The recommended minimum diameter for drums and sheaves is 30 times the rope diameter, or a 30-inch drum for a 1-inch wire rope. In the shovel under discussion this specification is met by the use of interchangeable lagging. When the present design is converted to dragline, clamshell or lifting crane it is possible to increase the drum size, by applying larger lagging, to 32 or more times the rope diameter. This has effected considerable economy in operation and in the life of the wire cables.

In the development of this unit large drums were an outstanding aim. Instead of following the customary practice of working out the power plant and designing the machine forward to the drums, the drum diameters desired were established first and from there the design worked back toward the power plant. It was found that contrary to all former theories, this practice lent itself to even more compactness of the machinery.

Balance and stability are imperative in this type of equipment. This is obtained by reason that all of the machinery is located to the rear of the center pin. Employed for the crawler truck frame is a one-piece annealed steel cast-

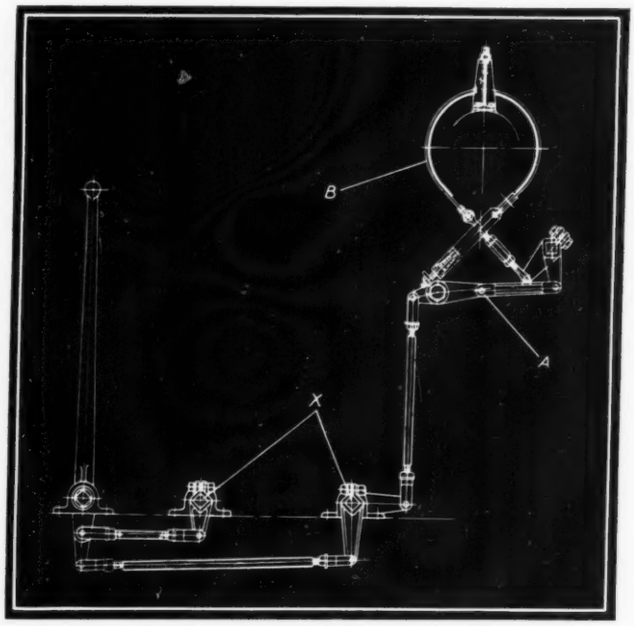


Fig. 3—Employment of square shafts and toggle joints insures positive action of the control mechanism

ing with supports and gearcase cast integral. Ten bolts hold the gear for rotating the superstructure rigidly in place. Machined on top of the gear is a wide path for the rollers on which the superstructure is mounted. The freedom with which this can be rotated, even though weighing 60,000 pounds, is indicated by the fact that a man pushing on the side of the dipper can revolve the entire upper structure.

The center shaft is made of alloy steel, heat treated, and operates through the bronze bushed center journal. To eliminate lost motion and backlash it is splined at its upper end for receiving the bevel gear, and at its lower end for the double bevel gear which affords the two speeds for traveling. All other drive shafts on

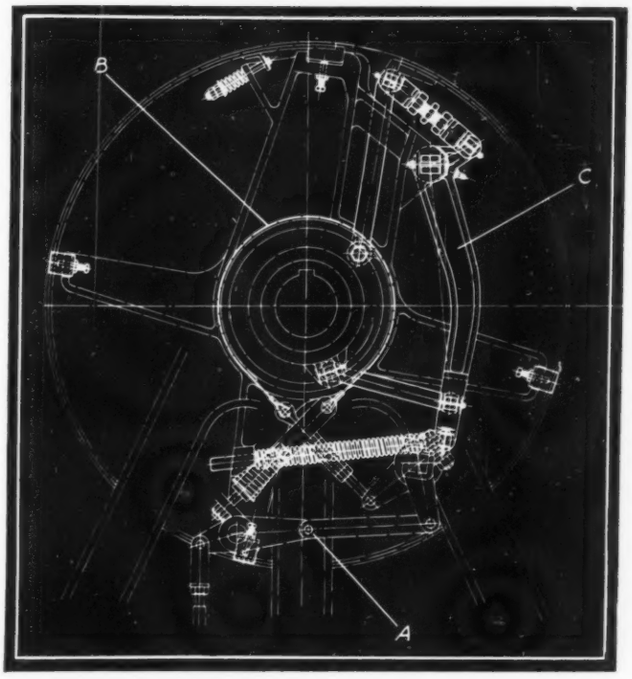


Fig. 4—The auxiliary brake sets in operation the mechanism of the internal expanding clutch of the rope drum

which are mounted sliding members are splined to obviate the possibility of vibration due to wear and backlash.

In the crawler truck the entire weight of the machine is supported on four stationary axles on which revolve four large track rollers on either side. Crawler treads are supported around these rollers and are driven by the rear roller through a sprocket chain. Either crawler tread may be thrown out of commission by the operator in the cab, allowing the machine to turn in a wide radius, or one can be locked to effect a sharp turn in its own radius. Provision for taking up the wear in the treads and drive chains is made in the adjustable side bars on the outside of the rollers. These bars are easily accessible and also form an outboard support for the four axles. Another feature characterizing the flexibility of the unit is the method of lengthening the crawler truck when increased bearing surface for the crawler treads is required. By uncoupling the tread, adding the necessary sections and installing another wheel in each end of the crawler unit, the extension can be effected without dismantling the machine.

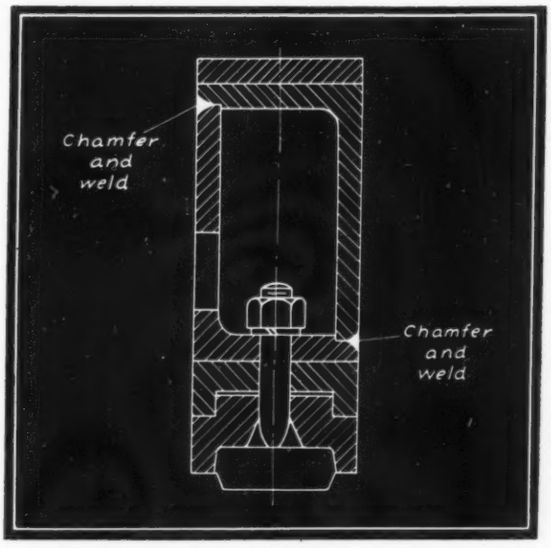


Fig. 5—Welded construction is employed to produce a strong box-type beam for the dipper handle

Construction of the dipper handle, which is of the two-arm type, is of interest. Each arm is made up of two angles welded together at the corners and forming a box section, to which is attached the necessary racking. Details of this design are shown in cross section, Fig. 5. The boom, of box construction, is composed of pressed steel members. Number of rivets used has been reduced to the minimum.

In selection of metals every effort was made to use as much standard material as possible, and for that reason large unit steel castings are employed throughout. The use of alloy steel has been limited to the shafts, gears, and some necessary forgings.

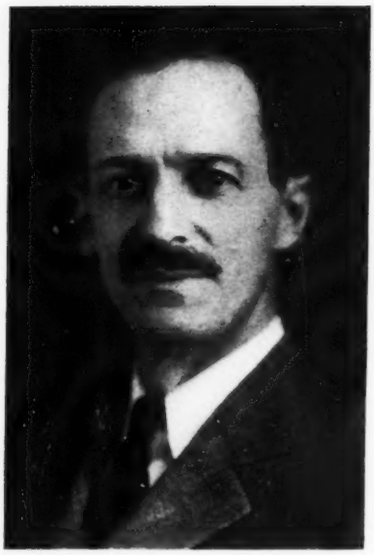
Square Shafts Eliminate Lost Motion

To insure positive and instantaneous response to the control mechanism, all levers and knuckles, instead of being keyed to round shafts, which usually is standard practice, are broached out square and slotted for clamping on square shafts by draw-bolts. These square shafts and broached levers are shown at *X*, Fig. 3. By this method the minimum of lost motion is assured in the control mechanism during the life of the machine. All controls are within easy reach of the single operator, who has full and unobstructed view of the machinery as well as the work being done.

The unit is finished in a distinctive combination of colors—the boom, machinery and truck being black, the lower half of the outside of the cab being painted a bright red, and the upper half aluminum. Inside of the cab is finished in white and provided with electric lights, supplied from the self-starter batteries on the engine. Gear ratio from the 900 R. P. M. engine to the drum shaft is approximately 60 to 1, and to the final drive on the crawler truck about 120 to 1.

During experimental and manufacturing development of the shovel, daily reports were sent in to the factory covering the operation of units placed purposely in different types of arduous service. Major changes in design were found unnecessary but many minor improvements resulted.

Treats Vibration in New Volume



A. L. KIMBALL
Author of "Vibration Prevention in Engineering."

Vibration Prevention in Engineering, *by Arthur L. Kimball; published by John Wiley & Sons Inc., New York; available through* MACHINE DESIGN *for* $2.50 *plus* 15 *cents postage.*

Perhaps no one phase of engineering is receiving more attention in the design of modern machinery than elimination of vibration. Various aspects of the subject have been treated in recent issues of MACHINE DESIGN, and almost concurrently a new book by Arthur L. Kimball of the General Electric research laboratory augments the data available to designers. The volume is intended as a reference work for practicing engineers and particularly for the students in the advanced course in engineering given by the author's company.

Purpose of the data is to give in concise form a resume of the factors which play a part in vibration prevention in engineering. Because it is impossible to do effective work in this field without some grasp of the fundamentals on which the subject is based, the book is recommended as one of the works which all design engineers should read. Mr. Kimball's method of presentation has been to develop each topic in a way which leaves no questions as to the basic logic involved, but at the same time to omit long analytical developments not essential to this understanding.

By clear visualization of theory and directness of attack on practical problems, the value of the presentation has been enhanced. Typical chapters deal with turbine wheel vibrations, balance of rigid rotors, prevention of noise and vibration through elastic suspension, shaft whirling due to internal friction and to oil action in journal bearings, and measurement of damping constants of solid materials.

The Internal Combustion Engine, *by D. R. Pye; published by Oxford University Press, New York; available through* MACHINE DESIGN *for* $4.00 *plus* 15 *cents postage.*

Principles which underlie design and operation of internal combustion engines constitute the point of view from which Mr. Pye has written his new book. It is intended for the engineer to study before he becomes involved in the intricacies of manufacture. Although dealing with principle rather than practice the data aims nevertheless at providing the groundwork of a practical knowledge of the subject.

One particularly interesting chapter covers detonation, also known as "knocking" or "pinking." The occurrence of detonation is much bound up with questions of engine design but recent research has shown that essentially it is a chemical and physical problem. Tables and diagrams are used extensively by the author in illustrating and clarifying his text.

Motion and Time Study, *by Allan H. Mogensen; published by McGraw-Hill Book Co. Inc., New York; available through* MACHINE DESIGN *for* $2.50 *plus* 15 *cents postage.*

In the capacity of editor Mr. Mogensen has woven together a wealth of data on the subject of motion and time study. Some of the material included is not new; however, as Mr. Mogensen says, if the manner in which the subject is presented enables those in the field to start where Frank B. Gilbreth, pioneer in the field, left off, they will have added to the present store of knowledge considerably more of both the principles and technique.

Chapter 15 is of particular interest to designers inasmuch as the relation of motion study to machine design is discussed. Instances are cited where study of machine operation has resulted in simple changes in some cases and in others complete redesign—done to improve the efficiency of the equipment. One of the most valuable instruments employed in this type of work is the camera. Motion pictures of operators tending their machines often tell an amazing story. The amount of benefit the designer can gain from a careful camera-aided analysis of his machine is incalculable.

Fig. 1—(Right)—Torsional deflection forces on a bar. Fig. 2—(Below)—Spring coils begin at loops

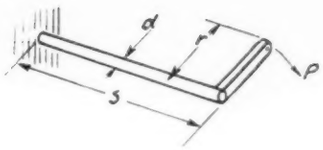
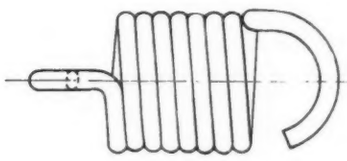
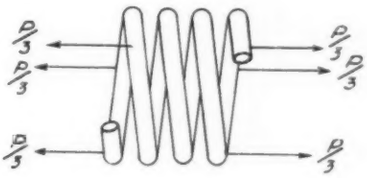


Fig. 3—(Below)—Three forces spaced 120 degrees apart give accurate check on deflection in the end coils





Spring Design Must Take Into Account Inactive Coils

By R. F. Vogt

ALTHOUGH the torsional modulus of elasticity has been known to be a quantity proportional to the tensional modulus of elasticity and to be characteristic for the material, and therefore constant for any material within its elasticity range, doubt still exists as to its value in connection with helical springs. In comparing calculations of helical springs with actual test performance, the torsional modulus of elasticity G for spring steel may range from below 10,000,000 to 12,000,000. Frequently 10,500,000 is chosen as the correct value. However, $G = 0.392E \doteq 0.4 \times 30{,}000{,}000 \doteq 12{,}000{,}000$. The difference in this value always is found when an error is made in the assumption of active coils in a given spring. The number of active coils as used in the deflection formula for helical springs does not always equal total number of coils or number of free coils. In most commercial helical compression springs the number of active coils must be more than the number of free coils, if we assume $G = 11{,}700{,}000 \doteq 12{,}000{,}000$.

The actual number of active coils for various helical spring designs and applications may be determined in accordance with the following views. Torsional deflection of a bar subjected to a torque Pr complies with the formula.

$$f = r\omega = 32r^2SP/\pi d^4G \quad (see\ Fig.\ 1)$$

in which

r = radius torque
S = length of bar
d = diameter of bar
P = load applied at radius r
G = torsional modulus of elasticity
ω = total twist angle of bar
f = deflection at end of radius r

For spring steel

$G = E \doteq 2\ (1 + 1/m)$
$E = 30{,}000{,}000$
$G = 11{,}700{,}000$
$m = 3.65$

These values correspond to the values given in

DUE to the torsional displacement between cross sections of the helical spring bar or wire in the so-called dead or inactive coils on each end of the spring, the total deflection of the spring is more than the deflection of the free coils. Mr. Vogt, assistant chief engineer, Allis-Chalmers Mfg. Co., analyses this problem in the accompanying abstract of a paper presented at the recent American Society of Mechanical Engineers' annual meeting in New York.

Huette, 26th edition. Transferring the formula for adaptation to helical springs,

$$f = r\omega = \frac{32\, r^2 \times 2r\pi \times n \times \cos\alpha \times (P/\cos\alpha)}{\pi d^4 G} = \frac{64 n r^3 P}{d^4 G}$$

in which

α = pitch angle
n = number of active coils

On some kinds of springs n, the number of active coils, can be accounted for easily; on others, including the largest number of commercial springs, n is not directly apparent. In a helical spring where the ends of the bar are connected solidly to a rigid radial lever reaching to the center of the coil where the load is applied, the active coils extend from lever to lever and equal the total number of coils. The same is the case in expansion springs with loop ends; the active coils begin and end at the loops if the loops join directly the cylindrical part of the coils, Fig. 2. In helical springs where the full length of bar is within the cylindrical part of the spring, as is the case on commercial helical compression springs and also on many kinds of expansion springs, the number of active coils extends beyond the number of free coils—i.e., the points of innermost support of the coil. Torsional deflection of the bar changes from maximum in free coils to zero in end coils. Torsional deflection within the end coils adds a certain amount to total deflection of the spring. This can be determined in many cases with absolute accuracy and in all other cases can be approximated accurately enough to satisfy practical applications.

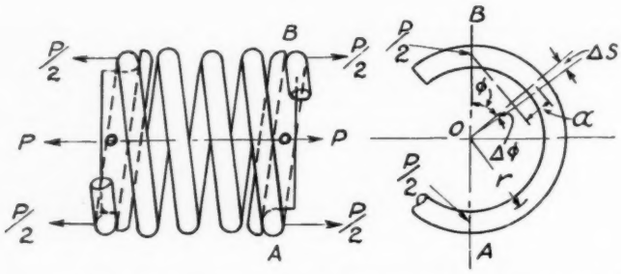


Fig. 4—Load is applied by yokes which reach diametrically from one side of the spring to the other

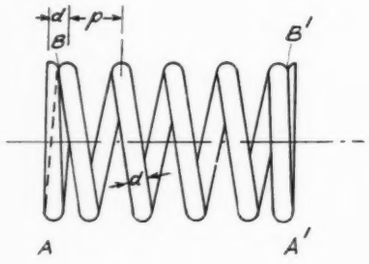


Fig. 5—Basic design of spring gives full bar action in end coil

To illustrate deflection effect of the end coils, we assume an open wound helical expansion spring on which load is applied by means of yokes on each end reaching diametrically from one side of the coil to the other, Fig. 4. Load P is applied at the middle of the yoke by means of a pivot so that each end of the yoke transmits the same pull, $P/2$, on the spring. As shown in the beginning, the effect of the pitch angle eliminates itself in the deflection formula, and we may assume the end coil to be in a plane vertical to the center line of the coil, and the forces vertical to the plane of the coil. We consider the torsion in any differential section $\triangle s$ of the bar between points A and B. The moment acting on the differential $\triangle s$ is

$$M = (P/2)a = (P/2) \times r\ (1 - \cos\phi)$$

The angle of twist in $\triangle s$ is $\triangle\omega$

$$\triangle\omega = 32\, M \times \triangle s/\pi d^4 G$$

$$\triangle s = r\triangle\phi$$

$$\omega = \int_0^{\pi} \triangle\omega = \int_0^{\pi} [32\ (P/2) \times r \times (1 - \cos\phi)\ r \times \triangle\phi\ ]/\pi d^4 G$$

$$\omega = \frac{16 r^2 P}{\pi d^4 G} \int_0^{\pi} \triangle\phi (1 - \cos\phi) = 16 r^2 P/d^4 G$$

Center o will have a total deflection of $f' = r\omega = 16\ r^3 P/d^4 G$ of the end coil due to force $P/2$ at B; force $P/2$ at A does not contribute to torsion in the end coil. This deflection corresponds to the deflection of ¼ coil subjected to the moment Pr. The same occurs at end $A'\ B'$, so the total deflection of spring is

$$f = 2f' + f'' = 2\ (16 r^3 P/d^4 G) + 64 n r^3 P/d^4 G$$

or

$$f = [64(n' + 1/2)\ r^3 P]/d^4 G = [8(n' + 1/2)\ D^3 P]/d^4 G$$

where

n' = number of free coils

In Fig. 3

$n' = 3\text{-}1/2$

$n = n' + 1/2 = 4$

If we apply three equal forces spaced 120 degrees apart as in Fig. 3, we find that deflection of the end coils is

$$f' = \frac{32(P/3) r^3}{\pi d^4 G} \left[\int_0^{4\pi/3} \triangle\phi\ (1 - \cos\phi) + \int_0^{2\pi/3} \triangle\phi (1 - \cos\phi) \right]$$

$$= \frac{32(P/3) r^3}{\pi d^4 G} \left[4\pi/3 + \sin\ (4\pi/3) + 2\pi/3 + \sin\ (2\pi/3) \right]$$

$$= [32 \times (1/3) r^3 \times 2\pi]\ /\ \pi d^4 G = [64\ (1/3)\ r^3 P]/d^4 G$$

For this condition the deflection of each end coil equals that of 1/3 coil under full torque of Pr. In this manner we can proceed with increasing the number of equal forces, evenly spaced around the end coil, and find that the deflection of each end coil corresponds to a deflection of full loaded coils as follows:

Number of equal forces acting on end coil	Space between these forces	Number of full-active coils necessary to produce same deflection as	
		One end coil	Two end coils
2	180	1/4	1/2
3	120	2/6	2/3
4	90	3/8	3/4
5	72	4/10	4/5
6	60	5/12	5/6
n	$360/n$	$(n\text{-}1)/2n$	$(n\text{-}1)/n$

Other load distributions show that $3 \times P/3$ is

the extreme derivation from $2\times P/2$ to be expected and that $2\times P/2$ is closest to the actual load distribution of most practical applications. Suppose part of load P is acting on A and the rest of the load is distributed equally for ½ circle from A over C to B, so that the resultant is in 0 (no load is possible between A and D as the coil leaves the spring end surface at A, D being the tip of the tapered end coil). The load per length unit along ACB being p, we find

$$pr\pi\ (r + 2r/\ \pi) = Pr \qquad p = P/r(2 + \pi)$$

$$\text{load on arc } ACB = r\pi p = P \times [\pi/(2 + \pi)] = 0.612\,P$$

$$\text{load in } D = P\ [1 - \pi/(2\ + \pi)] = 0.388\,P$$

The resultant of load on arc ACB and on D is in 0, as shown in the foregoing. For $3\times P/3$ distribution load in A would be $0.333P$; $0.388P$ being larger than $0.333P$ proves that the distribution shown in Fig. 6 is closer to $2\times P/2$ loading than the $3\times P/3$ loading and that the error would be considerably less than 1/12 coil if the $2\times P/2$ loading should be substituted for Fig. 6 loading. It is evident that for practical purposes only the first and second load condition can be considered, and that the first predominates in actual spring applications (see Fig. 4). For compression springs forces are applied in the opposite direction; deflection is also in the reversed direction, but calculations and results are otherwise the same. The design and application of a commercial helical compression spring are such that the load condition ranges between the first and second case given above, the first condition predominating.

Full Bar Section Used

The foregoing calculations are based on full bar cross section in end coil. This supposition is conformed to by most commercial compression springs, for that part of the coil which must be considered in the calculation. The basic design of the spring is shown in Fig. 5. The ends of such a spring are closed, ¾ of the end coil is tapered from full cross section to ¼ thickness at the end, the pitch changes at contact point B from p to d. Full cross section of bar is maintained from B to A, suggesting a load division of $P/2$ at A and $P/2$ at B. The possible variation from this load division cannot be much, and surely cannot come within the range of the three point loading of $3\times P/3$ (and shown by load distribution in Fig. 6), in which extreme case the difference would correspond to $1/3—1/4 = 1/12$ coil for each end correction.

The resultant of these forces is in the center line of the coil. If it should fall outside the center line, the spring would bend out sidewise, which in most compression spring applications does not occur to any appreciable amount. Within the range of the free coils, i.e., from B to B', Fig. 5, the bar is subjected to a shear force equal to $P/2$ and a torque equal to Pr. In a well-applied compression spring torque Pr is uniformly the same all along the bar, P acting in line with the center line of the coil. Due to the fact that the length of contact between the end coils increases slightly during increase in deflection, thereby effecting a slight decrease in active coils, the assumption of $2\times P/2$ load division is more justified, as the error in allowing a little less active coils than would correspond to actual possible different load distribution is compensated by the tensity of slight decrease in active coils during compression. It is therefore logical and practically correct to choose the $2\times P/2$ load division, for which case the effect of the end coil is equal to the effect of ¼ active coil. The total number of active coils for a helical compression spring, therefore, may be taken as the number of free coils (coils between contact points B) plus ½ coil. The deflection of a helical compression spring of the shape shown in Fig. 5 is:

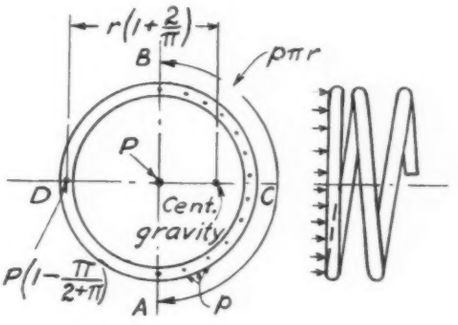


Fig. 6—Distribution of loading as it is applied to a compression spring

$$f = 64\,nr^3P/d^4G = [64(n' + 1/2)\,r^3P]/d^4G$$

A large number of tests have proved this contention, and it also has been found that G approximates 11,700,000 for any size and kind of spring steel bar.

Requires Large Quantities of Mercury

MERCURY required to operate the new 20,000-kilowatt mercury turbine just installed at the Kearny station of Public Service Corp. of New Jersey and a similar installation at Schenectady, both made by General Electric Co., represents about 89 per cent of the mercury consumed by the United States in an average year. Each installation requires 270,000 pounds of mercury. The institution of mercury vapor generating systems forecasts a new and highly significant factor in the mercury or quicksilver market. Present production in the United States is about 12,000 flasks a year, each flask containing 76 pounds. The amount of metal in these two installations would supply about 50,000,000 ordinary thermometers, the commonest use of mercury.

Editorial

Reduction in Capital Costs Should Be Aim in Current Design

IN THE turmoil of today's discussion of technological unemployment, almost everyone has jumped to the conclusion that the primary motive of designers of machinery is to create something that will save labor or put men out of jobs.

It is time, of course, that conditions during the past several decades have furnished a strong incentive for developing labor-saving machinery. Reducing the number of man-hours of productive labor per unit of product has been and will continue to be a challenge to machine designers.

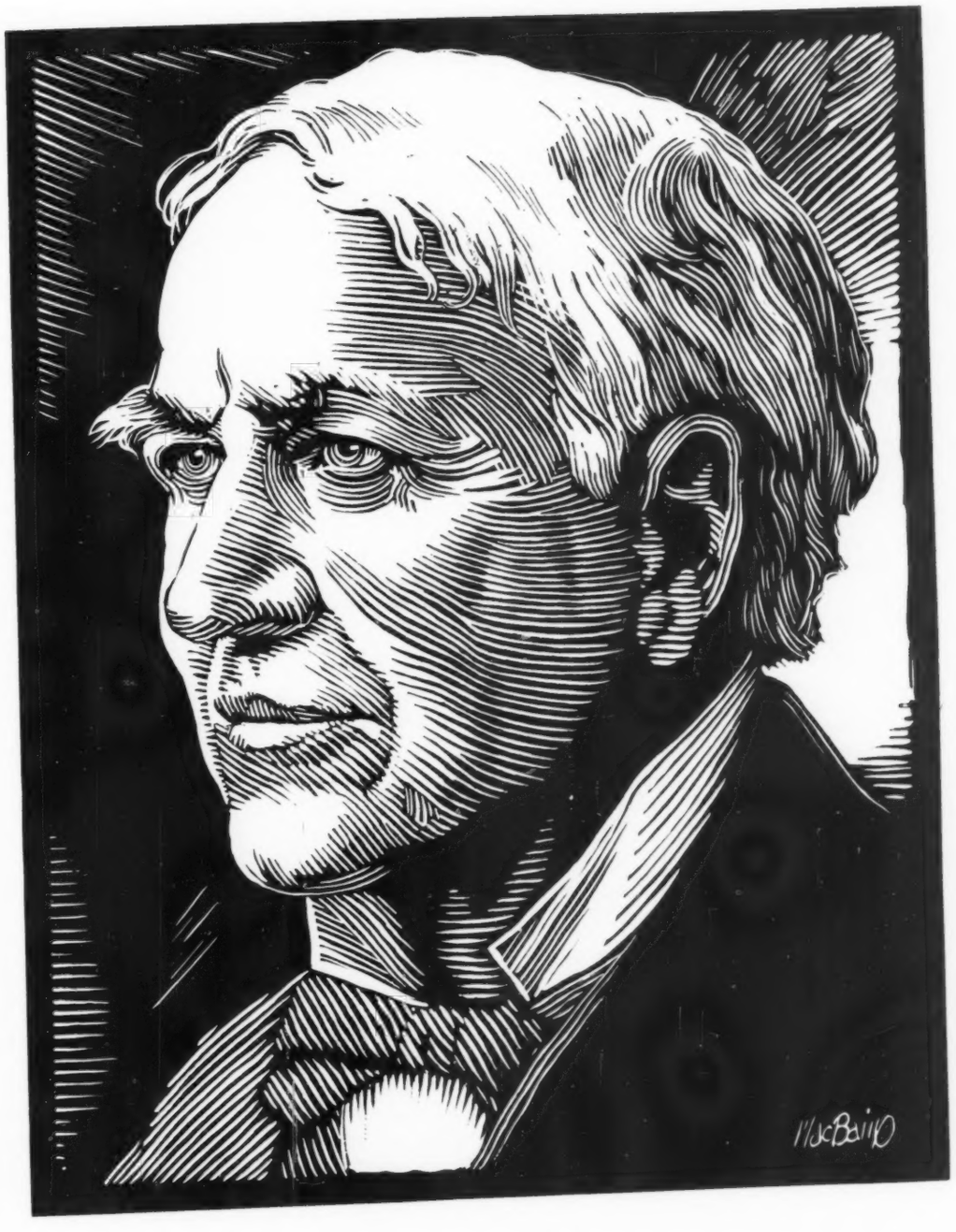
But it is a grave mistake to assume that economy in labor is the only major objective in design. A recent development in the rolling mill industry promises to produce a finished steel product of high quality but at only a fraction of the capital expenditure for plant and equipment required formerly. It is doubtful whether this mill will effect any savings in the use of labor. However it affords such marked economy in the use of capital that it promises to win prompt acceptance in the rolling mill industry.

Efficiency always will be the dominating motive in design, but whether the major emphasis lies in efficiency of time, labor, capital, material, cost of operation, floor space or other factors will depend upon the circumstances prevailing at the moment. Right now economy in the use of capital would seem to be an appropriate objective for designers.

Machining with the Flame!

WILL present machining methods, as far as certain materials and forms are concerned, be obsolete in the near future? Among the latest developments to come to light in this respect is one which involves employment of the oxyacetylene flame. "Flame machining," the name by which the process is known, shows unusual possibilities. Research work has been in progress for some time, and it now transpires that flame planing for instance, instead of machining with the conventional planer tool, can be carried out at astonishing speed. Turning, grooving, centering, drilling, etc., also have been accomplished satisfactorily.

One result of progress in this direction, as brought out by a speaker at the recent International Acetylene association's meeting, may be the redesign of some machine tools and design of others to utilize flame machining. Much remains to be done before this is likely to happen, but the possibility should be kept in mind both by machine tool builders and other designers alert to take advantage of new developments in production methods.



Thomas A. Edison

Master Designers

Thomas A. Edison

INVENTORS have been originating ever since Adam took the first crude step to improve his comfort, but never has the world seen an inventor who devised and improved more devices than Thomas Edison. No other man holds the same distinction of inventing the equipment for an entire industry. This erstwhile itinerate telegrapher, born at Milan, O., in 1847, was granted over 1150 patents, including patents for all of the basic devices used in the electric light industry.

EDISON'S taste did not run to mere discovery, he was vastly more interested in new development of practical nature. He covered every field of endeavor where he could visualize a need. His patience was colossal; ten years was spent in search for the secret of the storage battery; the world was scoured for the proper material for a light filament. Included among the mechanisms and processes he designed or improved are:

Dynamos	Wire drawing	Crushing machinery
Generators	Cement kiln	Submarine detectors
Phonograph	Vote recorder	Telephone diaphragm
Typewriter	Moving pictures	Multiplex telegraph
Mimeograph	Magnetic mining	Multiple arc lighting
Dictaphone	Storage battery	Electrical instruments
Light bulbs	Call box system	Plate glass manufacture
Vacuum pump	Concrete houses	Manufacture of chemicals
Stock ticker	Electric railways	Automatic telegraph relay
Torpedo boat	Synthetic rubber	Acid writing for the blind

IT HAS been estimated that his inventions are worth 16 billion dollars to the world, yet this still does not reflect his amazing ingenuity. Every invention was, in fact, a series of inventions, and his discoveries would have made him the inventor of the telephone, microphone and wireless telegraphy if he had followed all of them up. Never inactive, Edison was granted 40 patents in the last 12 years of his life, a lifetime's work for many distinguished men. He died at 84. One of his most widely used though less scientific compositions is not generally credited to him; he coined the word "Hello," in daily use on millions of telephones.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments and Questions from Our Readers. Machine Design Will Pay for Letters or Solutions to Problems Suitable for Publication

Determining Safe Beam Loads

To the Editor:

DIFFICULT calculations necessary in determining the safe load which can be imposed on a beam of irregular cross section are so laborious and have caused so much trouble that I would like to offer a simple graphical solution which will permit accurate and rapid determination of the moment of inertia of a beam. Once the moment of inertia and the section modulus are found, calculation of safe load reduces to a routine procedure. The graphical method is sufficiently accurate for all practical purposes if the drawing is made carefully to scale. The steps in this solution are as follows for one of the simpler beam shapes.

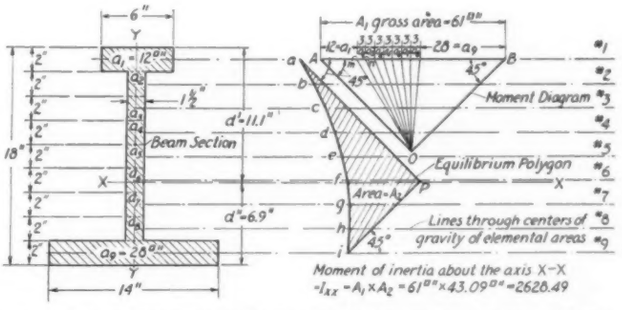
Draw the beam section as at the left in the accompanying illustration full size (or to scale) and divide it into any convenient elementary areas; the larger the number of these the more accurate will be the result. Compute the area of each (or measure it with a planimeter) and through the center of gravity of each elementary area draw a center of gravity line.

Now proceed to draw the moment diagram, upper right, by laying off accurately to scale on center of gravity line No. 1 the areas of each elementary area to a lineal scale, commencing at *A*. The length of this line, *AB*, will equal numerically the gross area of the whole section, which in this case is 61 square inches. Draw lines from *A* and *B* at 45 degrees to center of gravity line No. 1. These lines will intersect at some point *O* which is the pole of this diagram; to this draw the radial lines from each elementary area point.

Next draw the equilibrium polygon *api*, commencing at *a* on center of gravity line No. 1 and drawing the 45-degree line as shown, also from *a* draw the line *ab* parallel to line *mO* in the moment diagram, ending on line No. 2; draw *bc* parallel to *nO*, and so on till *i* is reached on the last center of gravity line, here shown as No. 9. From *i* draw the 45-degree line intersecting the other and locate the pole of this figure. This pole always falls on the line of the center of gravity of the whole section here marked as the *X-X* axis and may be projected on to the beam section. In this case the axis falls 6.9 inches from the base of the section.

Now measure the area of the equilibrium polygon *api* with a planimeter, or in any other manner that is accurate, and secure the area A_2. In this case we find it to be 43.09 square inches.

We now can compute the elements of this section namely: the moment of inertia about the



Graphical solution simplifies calculations when using a beam of irregular cross section

neutral axis $XX = I_{xx} = A_1 \times A_2 = 61 \times 43.09 = 2628.49$ inches^4; the section modulus for the upper half $= S_u = I/d' = 2628.49 \div 11.1 = 236.8$ inches^3; and for the lower half $= S_l = I/d'' = 2628.49 \div 6.9 = 380.9$ inches^3.

After drawing a few diagrams of various sections in this manner, one may become quick and expert at this method. For irregular and complicated shapes it is much preferred to any analytical computation, and is considered safer. There is less probability of an error occurring as any error is almost sure to be found immediately by the diagrams not closing properly; and the planimeter reading of A_2 can be checked.

—F. W. SALMON,
Richmond, Va.

Insuring Efficient Braking

To the Editor:

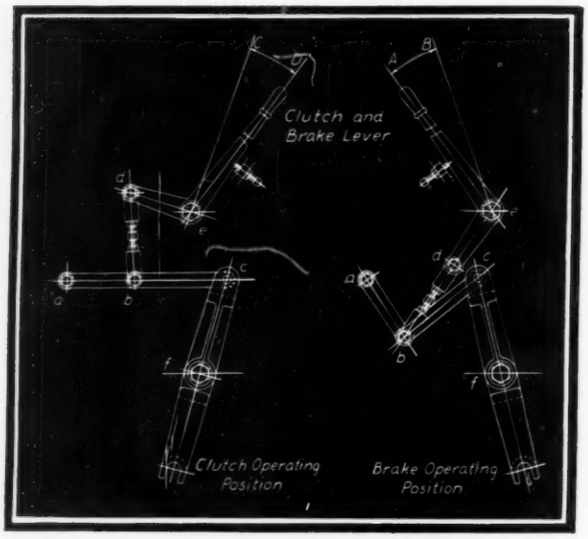
IN A heavy duty clutch and brake unit, where one unit was used as a clutch and another similar unit on the same shaft served as a brake,

considerable trouble was experienced in the units spreading due to the constant banging of the lever being thrown. This spreading caused the clutch and brake to become out of adjustment frequently. In addition, when a heavy load was imposed on the clutch it often became disengaged. To solve this problem the designers evolved a mechanism which may be of use to others.

To remedy both of these conditions a mechanism similar to the one shown in two positions in the accompanying diagram was used. It consists of three links, one being adjustable, and two levers. One link pivots at *a* and the levers pivot at *e* and *f*.

When the clutch is thrown in, points *a*, *b* and *c* form a straight line and cannot be broken over-center except by the operator. This prevents the clutch from disengaging under load, and the clutch yoke cannot go over any further than the combined length of the two links—at which point the clutch is adjusted to be run.

When the clutch is thrown out and the brake



Lever mechanism prevents clutch or brake spreading under heavy shock loads

applied, from the angular distance *D* to *C* there is a mechanical *force* advantage of 2.5.

From *C* to *B* there is a mechanical *throw* advantage of a similar amount but through this distance little force is required as the clutch has been disengaged and the brake does not begin to be applied until point *B* has been reached; there the *force* advantage again occurs from *B* to *A*.

When the brake is applied *b*, *d* and *e* form a straight line holding the brake applied until the toggle is broken over by the operator.

This mechanism is comparatively simple, yet it prevents separation of the clutch and brake units through constant shock, and also prevents the clutch or brake from becoming disengaged except at the operator's election. In addition, these links provide a mechanical advantage on each end of stroke at the point where the force is needed most.

—Lloyd A. Whittaker,
North Attleboro, Mass.

Create Bushing Standards!

To the Editor:

Inasmuch as the present bushing standards are little more than a collection of stock sizes and since they cover only the sleeve type of bushings, it would be of great help to designers if a well worked out and complete bushing standard could be formulated by the bushing manufacturers as a whole or by the American Standards association.

A bushing standard should cover the major dimensions and tolerances of sleeve, split, collar and self-aligning types and in addition the details of oil grooving. Standards for physical and chemical properties of bearing materials have been drawn up by the Society of Automotive Engineers and the American Society for Testing Materials, while a number of bearing manufacturers have their own standards for materials. These material standards should be revised and incorporated in the proposed bushing standard as a part thereof.

Machine designers would welcome such a standard. It would eliminate the necessity for detail bushing drawings, which now are required for all types of bushings other than the plain sleeve. A bushing standard also would reduce manufacturers' production costs because of the greater number of bushings of each size produced.

If bushings were standardized, many manufacturers would stock them in the various materials in which they specialize. Hence the designer of machines would have available to him economically, a larger variety of bearing materials than at present. Recently I had a need for a few graphited bronze bushings. A local manufacturer informed me that their graphited bronze bushings were made by a process that did not lend itself to the economical manufacture of the quantity of bushings desired. If standardized, these bushings probably would have been made in quantities for stock and hence my requirements could have been met economically.

Manufacturers of ball and roller bearings have given the designer the load carrying capacity of their bearings under various condi-

tions of service. Would it not be of great assistance to the designer if bushing manufacturers did likewise? The load carrying capacity of the various bushing materials is not too well known and handbook data on this subject is far from complete. Tabular information of the load carrying capacity of the different bushing materials under the various service conditions would be the natural outgrowth of a bushing standardization program.

Any interest you may be able to create within those bodies which should formulate a bushing standard would be appreciated.

—ARTHUR J. STOCK,
Rocky River, O.

Eliminating Drawing Confusion

To the Editor:

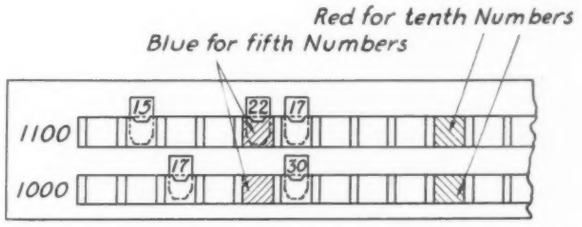
DESIGN department operation problems such as the one outlined by M. W. Elmendorf in the October issue are of pertinent interest to all engineers. This discussion brings to my mind a problem along these same lines. The difficulty of finding drawings in the design department is one which has irritated every designer at one time or another. The problem consists mainly in overcoming lack of orderliness, selfishness, lack of consideration of the rights of others, or a sense of superiority to justifiable rules and regulations.

Type of system depends on quite a number of factors such as number of men employed, whether or not the drawings are allowed to circulate freely or only to a limited amount, also whether or not designers are allowed to remove drawings from the filing drawers themselves.

In one office the charging out of drawings is achieved by using a wall rack of small pockets, each numbered to correspond with a drawing, into which a small ticket is slipped as a drawing is issued. The slip bears the number of the man who took out the drawing. The rack shown in the accompanying illustration is made of close-grained light cardboard. Each draftsman has about thirty of the tickets and section leaders have more according to requirements. With 150 men in the organization the scheme works well with a filing vault personnel of only two boys.

The type of work is such that drawings of greater age than three years almost invariably become obsolete, except as a matter of record. The numbering system is consecutive so that the wall chart or rack always can be kept within a reasonable size. In a wall space 70 by 40 inches, about 3000 drawings can be indexed in this way. In the office under discussion, each complete unit of design required about 400 drawings of individual pieces so that a rack of the size mentioned takes care of six to eight designs.

With this system the attendant can determine quickly if a drawing is in file or, if not, to whom it is charged. This eliminates much handling of drawings in the drawers which would be necessary if a search were made there for the drawing each time.



Wall chart detail for assisting in locating drawings quickly in design department

The wall rack must be kept up to date with the new drawings being made. This is done by subdividing decimally and labelling only the main thousands and hundreds divisions, while suitable colored marks denote the tenth and fifth numbers. Little effort is required on the part of the attendants. An additional index indicates the names of the men in the department corresponding with the numbers issued to them on the tickets.

—W. S. BROWN,
Auburn, N. Y.

Calculator Simplifies Drive Selection

CALCULATION of the units involved in a V-belt drive is simplified by a new instrument which instantly selects the ideal drive for any installation. Tables, slide rule, etc., are eliminated as a turn of the instrument dial gives specifications for the drive immediately. All answers are given in actual figures or words and no scale reading or setting is necessary. In addition, the calculator incorporates all the data usually included in handbooks issued by manufacturers.

Information given includes the diameters of the driver and driven wheels, number and size of ropes, choice of center distances with rope for each and exact horsepower of the drive. If there is a choice of several drives which can be used, specifications for all of them will appear on the dial. All irrelevant data is kept out of sight. Further information on the calculator may be obtained from Allis-Chalmers Mfg. Co., Milwaukee.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

MEMBERSHIP of the board of directors of the American Standards association, now includes Dr. Lyman J. Briggs, acting director of the bureau of standards. He represents the United States chamber of commerce. In addition to his duties as head of the bureau Dr. Briggs is acting chairman of the federal specifications board and of the national screw thread commission.

Since college days he has been in the service of the government. When the United States entered the war in 1917 Dr. Briggs was detailed by executive order to the bureau of standards and was assigned to problems in the field of aerodynamics and ballistics. During this period he developed with J. F. Hayford, a gyroscopic instrument for maintaining an artificial horizon below deck as an aid in directing gun fire from battleships. Those instruments now are installed on many of the battleships of the navy.

In 1920 Dr. Briggs was made chief of the division of mechanics and sound of the bureau of standards and in 1921 received in collaboration with P. R. Heyl, the Magellan medal for a new earth inductor compass for use in aircraft. He also made a special study of the characteristics of airfoils held in air streams moving at speeds as great as that of sound, which provided information applying directly to the design of aircraft propellers. In 1926 he was appointed assistant director of the bureau of standards and became acting director on the death of Dr. George K. Burgess in July of this year.

FOR his paper on "Equivalent Circuits," presented at the past winter convention of the American Institute of Electrical Engineers, Frank M. Starr recently received the Noble prize. The gift which was established in 1929 in the memory of Alfred Noble, a prominent engineer in the half century preceding 1914, stipulates that the recipient must be under 30 years of age. The award is confined to members of the four founder engineering societies and the Western Society of Engineers.

At his graduation from the University of Colorado in 1928, Mr. Starr received the degree of bachelor of science in electrical engineering. In July he entered the service of General Electric and spent one year on test, which was followed by a year in the general engineeering department. For the past two years he has been a member of the central station engineering department.

The award is confined to members of the four founder engineering societies and the Western Society of Engineers. Selection of the individual who is to receive the honor is made by a committee including one representative of each of the five organizations.

PIONEER in the develcpment of organic accelerators which speed up the vulcanization of rubber, George Oenslager has distinguished himself as an outstanding chemical engineer in the rubber industry. His work has brought about longer life to all rubber products, a factor which has increased the value of this substance as an engineering material. For his achievement Mr. Oenslager has been awarded the coveted Perkin medal, which will be presented to him early in January.

Born September 25, 1873, in Harrisburg, Pa., Mr. Oenslager obtained his early education there. Later he matriculated at Harvard with the ambition, he confided later to associates, of becoming a second Edison. He became so engrossed in chemistry, however, that he forgot his earlier ideas. After graduation in 1894 he took a post graduate course, obtained his master's degree, and then went into the pulp and paper industry where he remained fcr ten years in research.

May 1905 found him in the laboratories of the Diamond Rubber Co. and a year later he started work to find a means by which cheaper wild rubbers could be made to vulcanize as rapidly as those of higher grade. The result was his discovery of organic compositions as accelerators of vulcanization—with an estimated savings of at least $50,000,000 a year tc motorists alone.

NOTABLE industrial achievement in initiating mass production of copper from low grade ores through application of engineering principles, recently won the 1933 John Fritz

Leaders in Design, Engineering and Research

LYMAN J. BRIGGS

FRANK M. STARR

GEORGE OENSLAGER

DANIEL C. JACKLING

gold medal for Daniel Cowan Jackling. As a result of his pioneer work many billions of pounds of copper have been added to the world's potential reserves.

A native of Missouri, but now a resident of San Francisco, Mr. Jackling holds executive positions in a number of companies. It was in 1899 while working at Mercur, Utah, after he had been graduated with a degree in metallurgical engineering in 1892, that he foresaw the possibility of reducing costs in mining and milling low grade copper ore by operating on a scale never before contemplated. He put into effect the idea of mining the ores occurring at or close to the surface with steam shovels, and of recoving the small copper content in concentrating mills far beyond the size of those which had been the usual practice.

Mr. Jackling has contributed in an outstanding way to the success of many lines of industry. A large supply of copper at reasonable prices has been fundamental to the development of all phases of the electrical industry, as well as to automotive design. A primary feature of his public work was his distinguished service to the government during the World war as director of explosives.

* * *

John Lyle Harrington of the consulting engineering firm of Harrington and Cortelyou, Kansas City, Mo., and John H. Gregory, consulting engineer, Baltimore, have been appointed by President Hoover on the board of engineers which will pass upon the engineering phases of construction projects on which the Reconstruction Finance Corp. has received applications for loans.

* * *

Dr. Irving Langmuir, associate director of the General Electric research laboratory, recently was awarded the Nobel prize in chemistry. A picture and biographical sketch of Dr. Langmuir appeared in the April issue.

* * *

W. A. Hillebrand, formerly electrical engineer for Ohio Insulator Co., division of Ohio Brass Co., recently accepted a professorship in electrical engineering at the University of California.

* * *

Lewis S. Reid, formerly chief engineer of the Magnetic Analysis Corp., has joined the staff of Lucius Pitkin Inc., as associate metallurgist.

* * *

Dr. Willis Rodney Whitney, organizer and for 32 years director of the research laboratory of General Electric Co., retired November 1 from that position because of poor health. He was succeeded by Dr. William David Coolidge, senior associate director of the laboratory. Dr. Whitney continues as vice president in general charge of research. Biographical sketches of Dr. Whitney and Dr. Coolidge appeared in the April, 1931, and March, 1932, issues of MACHINE DESIGN respectively.

* * *

R. C. Bret, formerly affiliated with Trundle Engineering Co., Cleveland, and for the past year engaged in special engineering work for the Glidden Co., recently has been appointed director of engineering for the 21 plants of the latter company, with headquarters in Cleveland.

* * *

Victor J. Cucci, consulting engineer, formerly of the firm of Kimball & Cucci, and William A. Brown, consulting engineer, have announced the opening of offices for practice of engineering under the name of Cucci & Brown Inc., New York.

* * *

Oliver Smalley, president of the Meehanite Research institute for the past three years, was re-elected to that post at the recent annual meeting of the organization in Cleveland. A picture and biographical sketch of Mr. Smalley appeared in the May, 1931, issue.

* * *

C. M. Burrill has resigned his position as research engineer with the Rogers-Majestic Corp. Ltd., Ontario, Canada, to return to the R. C. A. Victor Co. Inc., Camden, N. J., where he will be connected with the research division.

* * *

F. J. Rudd has been appointed managing engineer of the motor department of the General Electric Co. He succeeds L. E. Underwood, who has been made manager of the Pittsfield, Mass., works of the company.

* * *

James I. Clower, formerly affiliated with the Vacuum Oil Co., New York, as technical editor, now is assistant professor of machine design at Virginia Polytechnic institute, Blacksburg, Va.

* * *

W. S. Shipley, president York Ice Machinery Corp., York, Pa., is the new president of the Refrigerating Machinery association.

* * *

F. W. Vigelius and Russell Johnson have joined the teaching staff of the mechanical engineering department at Michigan College of Mining and Technology, Houghton, Mich. The former was with Ingersoll Rand Co. for about eight years, serving in the inspection, produc-

tion, research and machine design departments. Mr. Johnson formerly was chief draftsman of the O. E. Zekely Corp., Holland, Mich., and later held the same position with Comet Engine Corp., Madison, Wis.

* * *

P. C. Clarke, formerly in charge of spring design at the Philadelphia works of General Electric, has been placed in charge of the engineering and research departments, Hunter Pressed Steel Co., Lansdale, Pa.

* * *

H. E. Rosebrook has accepted a position in the engineering department of the Gibson Electric Refrigerator Corp., Greenville, Mich. He comes from Springfield, Mass., where he was connected with Westinghouse for several years.

* * *

E. J. Rutan, supervisor of the test bureau, New York Edison Co., has been reappointed chairman of the American Institute of Electrical Engineers committee on instruments and measurements.

* * *

Fraser Jeffrey, electrical engineer, Allis-Chalmers Mfg. Co., Milwaukee, recently was elected president of the Engineers' Society of Milwaukee.

* * *

D. W. McLenagan has been appointed assistant engineer of the commercial engineering division of General Electric's air conditicning department.

* * *

L. C. Stowell, president of Dictaphone Corp., Bridgeport, Conn., recently was elected president of the Equipment Manufacturers' institute.

* * *

J. B. Fisher, chief engineer, Waukesha Motors Co., Waukesha, Wis., has been elected a director of the company.

* * *

J. J. Donovan, manager of the air conditioning department, General Electric Co., was elected a director of the American Oil Burner association at the recent regular quarterly meeting of the board of directors.

* * *

Gen. Thomas S. Hammond, president of the Whiting Corp., Harvey, Ill., has been nominated for the presidency of the Illinois Manufacturers' association. Gen. Hammond's picture and biographical sketch appeared in the June issue.

* * *

Fred H. Dorner, mechanical engineer, Milwaukee, and vice president of the American Society of Mechanical Engineers, has been appointed alumni representative on the board of visitors of the University of Wisconsin. A picture and biographical sketch of Mr. Dorner appeared in the Feb., 1931, issue.

Obituaries

TINIUS OLSEN, 86, known internationally as a designer and manufacturer of testing machines, died at Philadelphia, October 20. Born at Kongsberg, Norway, he was educated in various schools in his native land. In 1869 he came to the United States, becoming a draftsman for William Sellers & Co., Philadelphia. At a Lutheran Sunday school he became acquainted with brothers named Riehle, and for them designed his first testing machine. In 1872 he became identified with Riehle Bros., but in 1879 he founded his own business. At various expositions he won prizes, and was decorated by the King of Norway. To his native city of Kongsberg he made many benefactions. A son, Thornsten Y. Olsen, has been associated with him in business.

* * *

V. G. Apple, the inventor who installed the first electric lights on automobiles and was a pioneer in the development of self-starters, died recently at Dayton, O. He was the owner of 200 patents and 100 others that had expired. The Apple Electric Co., which he organized to manufacture his automobile starters, was sold in 1914 to the Splitdorf Electric Co.

* * *

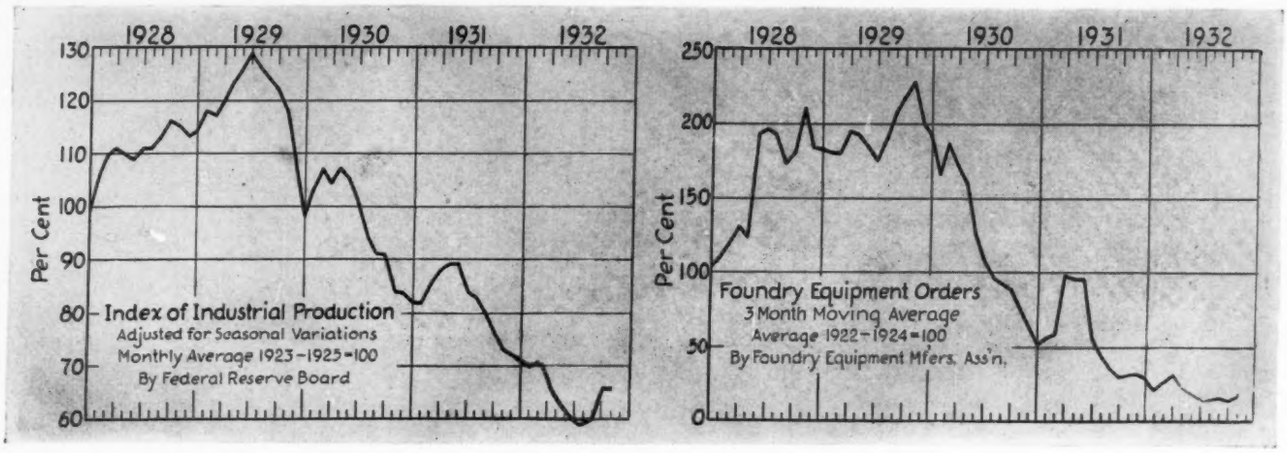
John Ripley Freeman, consulting engineer and president of the American Society of Mechanical Engineers in 1905, died recently aged 77 years. He was graduated from Massachusetts Institute of Technology in 1876.

* * *

Samuel Amdursky, consulting engineer and in charge of the mechanical department of the Taylor Instrument Companies, Rochester, N. Y., died recently after a short illness. He was 40 years of age. In 1915 he was graduated from the college of engineering of Syracuse university and formerly was associated with the Rochester Gas & Electric Corp.

* * *

Hans Luthi, general plant superintendent, Nash Motors Co., Kenosha, Wis., died recently from the effects of an operation. He was born in Switzerland, September 28, 1880, came to America in 1902 and gained recognition as an expert in automobile engine and transmission design and production.

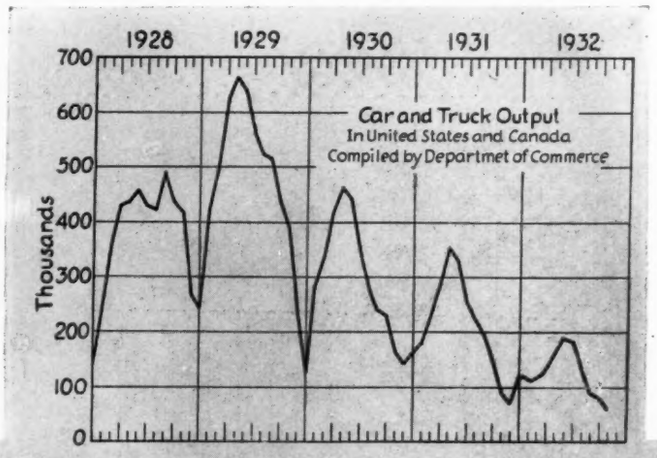


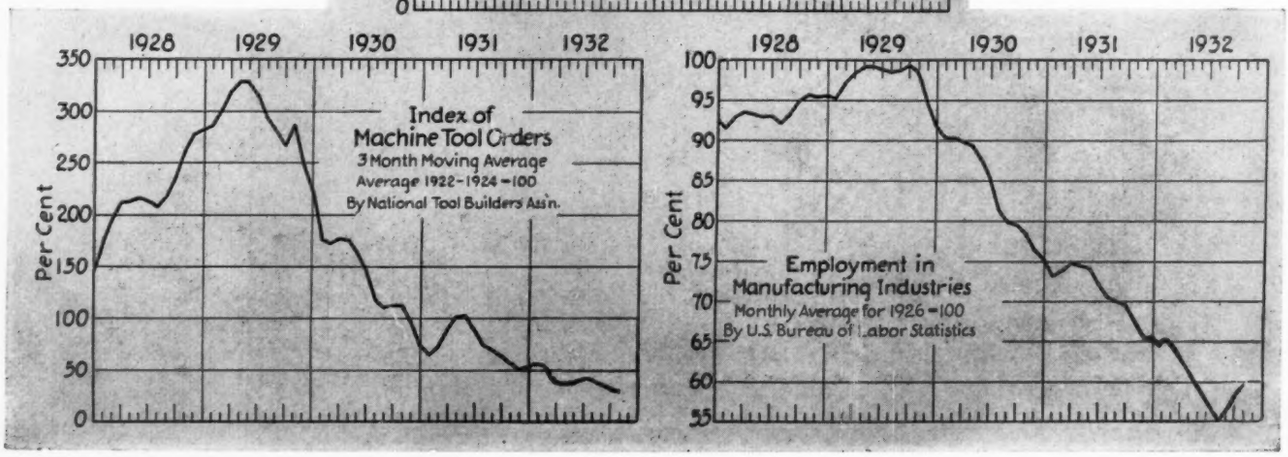
How Is Business?

INDICATIONS of improved sentiment, that most important business commodity, are given in a survey conducted by National Association of Manufacturers which shows that 76 per cent of the companies reporting believe prospects for the winter as good or fair, contrasted with 50 per cent a year ago. Such a reaction from companies among the first to sense the trend is of the most encouraging type.

The report also indicated that 62 per cent of the companies found their own business to be good to fair at the present time as compared with only 50 per cent who experienced this degree of activity a year ago. Improvement of this type has been reflected to some degree in business indexes and is undoubtedly the basic factor in the recent rise of industrial production and employment figures as they apply to manufacturing industries.

The improvement has lost some of the acceleration manifested in September and early October, but the recessions that have occurred in several important lines of business are clearly seasonal. A good example of this type of recession is the figures for freight car loadings which touched a high point in mid-October and then receded rather rapidly. However, this recession was not unexpected as these figures have declined during this season in the best business years on record. In fact, the current cycle was the basis for considerable optimism as the curve continued upward later into the fall than heretofore and downward acceleration was slower.





NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

RUBBER as an engineering material again asserts its importance in design, this time in the form of a sleeve to provide an effective governor for a fluid motor. The invention, patented by John R. Hoffman for Madison-Kipp Corp., Madison, Wis., is applied particularly to pneumatic tools such as grinders, Fig. 1. The governor, designated patent No. 1,886,546, prevents racing of the tool and possible breakage.

In Fig. 2*A* parts of the governor which include rubber sleeve 71, are in inoperative position, while *B* shows the parts expanded to throttle the turbine when it exceeds its predetermined maximum speed. Studying the operation of the entire unit, Fig. 1, it will be seen that exhaust from turbine runner 34 passes into barrel 11 and flows normally both around and through the governor unit on its course to the exhaust outlet at the outer end of the casing.

In practice the annular space, 89, Fig. 2*A*, serves merely as an operating clearance between protector sleeve 69 and the casing. Consequently this space is slight and permits the passage of only a small amount of air. On the other hand annular space 88 is much larger so as to allow free passage of exhaust fluid from the turbine runner and operation of the grinder spindle at full operating speed.

Sleeve 71 of the governor is made of specially cured rubber and all parts of the governor are dimensioned properly so that the spindle and attached parts may revolve up to a predetermined speed without the governing device functioning to reduce the speed. As soon as the spindle 33 exceeds this maximum speed, however, the increased centrifugal force imparted to the rubber sleeve causes the free portion to expand or stretch, thereby gradually cutting down and finally closing off entirely the annular space 88 when the rubber sleeve contacts with the interior of protector sleeve 69 as shown at *B*, Fig. 2. Expansion of rubber sleeve 71 also seals the annular series of openings 87 and passage of exhaust fluid beyond the governor is prevented, except for the small

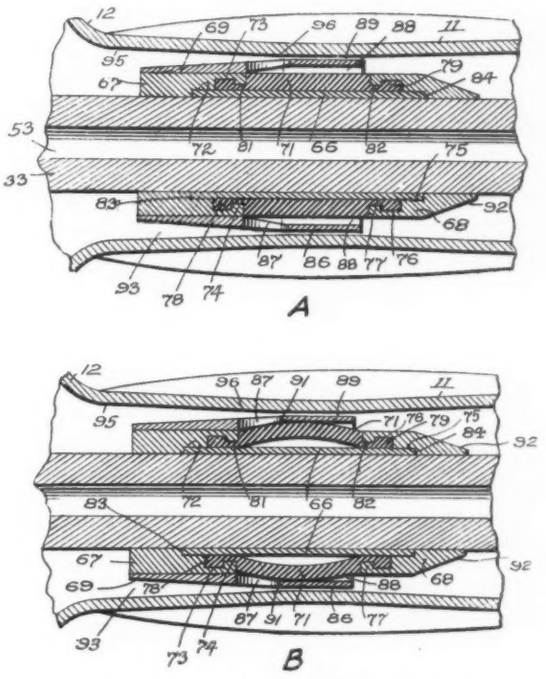


Fig. 2—Details of the rubber and protector sleeves of governor, the parts being expanded at B

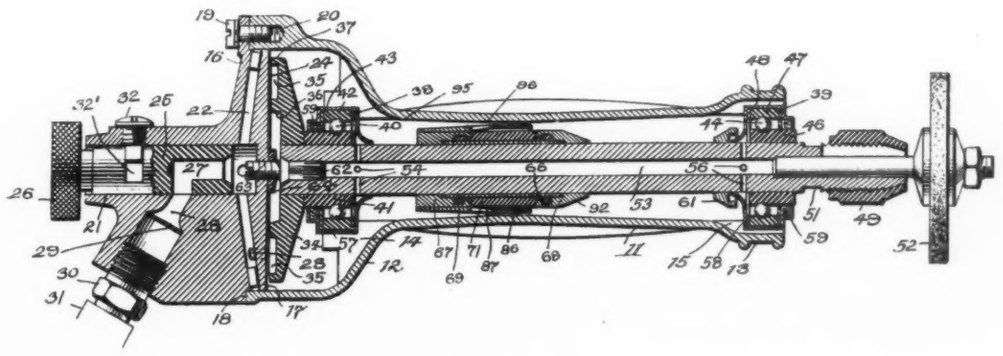


Fig. 1 — Pneumatic grinder employs governor embodying rubber sleeve which is controlled by centrifugal force to prevent racing of the tool and possible breakage

amount that escapes through clearance space 89. This is insufficient to drive the rotor at a suitable operating speed. When the spindle slows down the rubber sleeve of course assumes its normal shape. Outer sleeve 69 serves not only to limit the expanding action of of sleeve 71 but it also protects the sleeve from damage and wear.

TO SUPPLY lubricant to the upper bearing surfaces of a vertically arranged bearing assembly an impeller has been utilized by William C. Graul. He designed the device for Timken Silent Automatic Co., Detroit, and holds

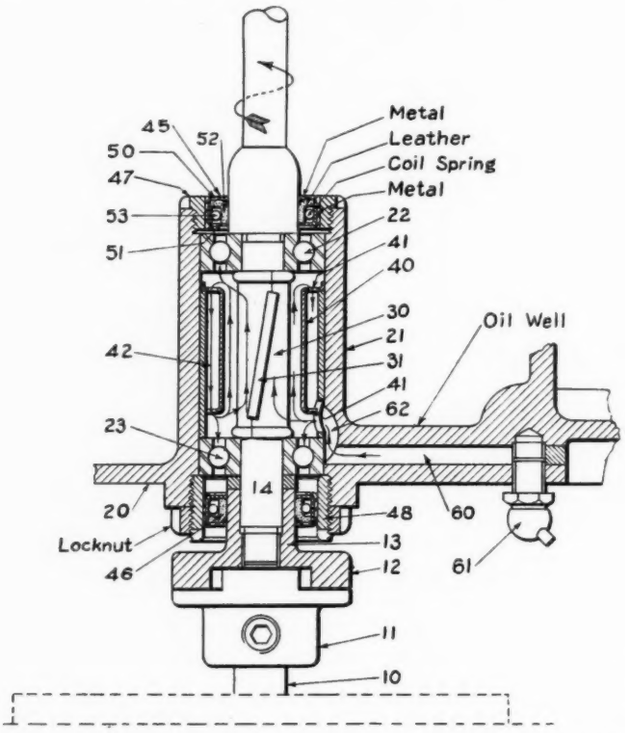


Fig. 3—Helically arranged impellers on vertical shaft pump oil to upper bearing surfaces of this assembly

patent No. 1,886,395 on it. The invention, Fig. 3, is adapted particularly to oil burners of the rotary type.

On shaft 14 between bearings 22 and 23 is a pump element or impeller 30 which embodies a sleeve having blades 31. These blades are arranged helically about the sleeve. The inventor prefers to make this part by blanking out and forming two halves, each with side flanges which when crimped or folded over serve the dual purpose of holding the parts together and forming two blades.

Within the body 21 is another sleeve 40, designated as a pump casing sleeve. This part 40 is supported in body 21 and spaced from the latter by means of end flanges 41 which are perforated to permit easy flow of oil between the sleeve 40 and part 21. Sleeve 40 is positioned within a short distance of the outer edges of blades 31, assisting in effecting the upward flow of lubricant when the shaft is rotated in the direction of the arrow, Fig. 3.

Inside the ring 51 is a flanged leather ring 52 which fits closely around shaft 14. Around ring 52 extends a contracting ring 53 of the coil spring type. Sealing rings employed are assembled as a unit and pressed into the threaded collars to form a tight fit. Lubricant is supplied to the sealed chamber through passage 60, entering by means of valve 61. The arrows indicate the passage of oil when the shaft is rotated.

DESIGN of packaging machinery abroad is progressing as indicated by the recent development of a German machine for automatically opening square bottom paper bags. This device recently was granted patent, No. 1,886,376 in this country. Xaver Dambacher is the patentee and the firm of Windmoller & Holscher, Lengerich, Westphalia, Germany, assignee.

Details of the machine are shown in Fig. 4. At the beginning of operation, guideway 28 raises and slides 26 and 27 approach each other moving to the right, Fig. 4 *A*, close to the vertical plane in which stops 80 are arranged. Lower ends of fingers 18 and 19 then are raised far enough to pass finger notch 74, *B*, Fig. 4, in one of the walls of the foremost bag 15 which touches stops 80. The other wall of the bag however is pressed slightly backward toward plate 16. At this point the bag is opened slightly.

In sequence, movement of slides 26 and 27 toward each other is effected by cams 40 and 41 and the train of levers so that fingers 18 and 19 are in contact with each other. Fingers 20 which were raised at the beginning of the working period approach each other and are lowered by cam 11. Cam 10 by means of lever 50, crank levers, spring 48 and suitable segments, rotates rods so that the attached levers enter the bag

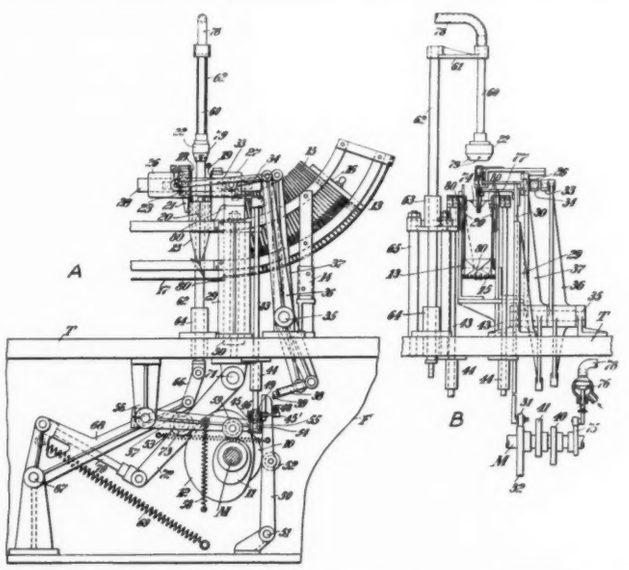


Fig. 4—Compressed air and lever mechanisms automatically open square bottom paper bags

opening and spreading out the folded tucks.

Immediately following this plunger 22 is lowered by action of cam 12. This plunger has a cross section similar to the inner section of the bag when filled, and is lowered close to the bottom. By employing compressed air delivered through holes 79 in the plunger head a complete spreading of the bag is insured. When the plunger has reached its lowermost position the cams come into action and start the various parts through a new cycle in which another bag is brought into place for opening.

IN COMBATING excessive expansion of clutch and brake parts due to heat generated by the certain amount of slippage that is desirable in

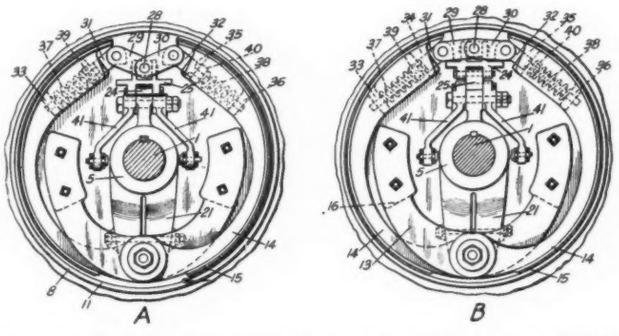


Fig. 5—Coil springs compensate for expansion of clutch parts when heat is generated in operation

operation, John D. McEwen has designed a clutch which incorporates resilient members to effect adjustment. The patent which recently was granted for the unit is designated No. 1,887,377 and the International-Stacey Corp., Columbus, O., is assignee. In Fig. 5 a side elevation of a pulley structure with the clutch as a part, the expanding band contracted, is shown at *A*, and a similar view with the band in expanded position is depicted at *B*.

Springs are employed to compensate automatically for the changes in temperature which result should the clutch be slipped during a hoisting operation, generating enough heat to cause expansion of drum 8. Coil springs 37 and 38 being under compression, Fig. 5 *B*, will cause the band section to follow the drum as it expands. Thus no manual adjustment is necessary to compensate for these changes in temperature and the apparatus readjust itself automatically as the temperature returns to normal.

The band is made up of two sections which are pivoted on the same pin. At one end these sections are spaced apart and can be expanded by a toggle lever mechanism; at the other end they extend beyond the pivot pin upon which they are mounted and are provided with counterweights which act centrifugally during idle rotation of the clutch to facilitate disengagement and to prevent dragging and accidental braking or clutching action of the band.

Splash Lubrication Fails at Subcritical Speed

(*Concluded from Page* 28)

safety. Substitute the value of R in equation (2) and solve for N.

$$R = \tfrac{1}{2} \text{ of } 1\text{-}\tfrac{1}{2} \text{ ft., or } \tfrac{3}{4}$$

$$N^2 = \frac{2935}{\tfrac{3}{4}} = 3920$$

$$N = 62+$$

Thus we conclude that splash lubrication will be maintained at 62 revolutions per minute and over, but will become uncertain and cease in proportion as we drop below that speed.

Suppose the low speed shaft must run at 25 revolutions per minute—what diameter must the gear be to supply satisfactory splash? Substituting in equation (2) the result is 9.4 feet. In most cases this dimension would be out of good proportions, so two expedients are open: One of the secondary gears may be employed as a splasher, or a set of scraping troughs may be supplied to the low speed gear so arranged as to scrape off the oil from the sides of the gear and lead it to the various bearings, etc. Of course these scrapers should not actually touch the gear. Employment of such scrapers involves the use of troughs connecting with all bearings.

How should oil be introduced into roller bearings? When the bearing is of the type having long cylindrical rollers, the oil generally can be fed through a hole in the center of the outer race. It then will work out to the ends in both directions. Drains must be provided at each end to guarantee circulation, otherwise the oil will tend to back up into blind ends, and churn and heat.

With tapered roller bearings, oil should be introduced at the smaller end, Fig. 3, because this type tends to pump the oil from the smaller to the larger end. In some cases oil is splashed into the larger end with apparently satisfactory results, but in all probability there is sufficient oil mist present in such cases to prevent damage at the small end.

Ball bearings and short roller bearings of the cylindrical type may be lubricated generally from either side, but the best results are obtained when the circulation principle is adhered to. Lead a splash trough to one side and provide a drain to the case, at the other.

The scheme of lubricating gears from splash, and packing the bearings in grease, has been tried and abandoned long ago. It seems impossible to keep the two grades of lubricant separate. However, such progress has been made during the last few years with oil seals that it would not be surprising to find some enterprising designer revising this scheme with success.

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

INVENTIVE minds of America are following new trends if records of the United States patent office are taken as a criterion. Certain types of devices are embraced in the applications in greater number, and at a time when total applications are declining at the rate of about 12 per cent over previous periods.

In the past year Commissioner Thomas E. Robertson notes that there has been an influx of applications for patents in connection with air conditioning, refrigeration, oil burners, dewaxing oils for automobile lubrication, alloys, electric clocks, the automobile industry and devices for rendering railroad travel more comfortable, safer and less expensive.

Many of the applications which have been received in increased volume represent the engineering talent of already established companies that wish to improve their products. Simultaneously, other applications reveal the ideas of American consumers. The commissioner points out that many of the patent applications on devices relating to railroads come from experienced technical railroad men, but also that there are applications springing from the brains of those whose only railroad experience has been as passengers. Such ideas sometimes lead the way to far-reaching changes, he declares.

* * *

Cites Value of By-products of Research

RESEARCH has made rapid strides in the past few years and is a particularly potent factor in raising the country out of the depression. Augmenting this much discussed topic Harry L. Horning, president, Waukesha Motor Co., Waukesha, Wis., emphasized the value of indirect results, collateral discoveries and the by-products of research in his recent talk before the Society of Automotive Engineers in New York.

Such by-products, he declared, in the majority of cases equal the primary objectives in importance and in many cases are of greater consequence. He described a case of research instituted to develop a cylinder iron that would not "grow" in service; from it more than 10 by-products resulted. Warning against the trend to go off on a tangent during research and the tendency to delay the finish, Mr. Horning said it seems that bringing a research problem to conclusion is the most difficult part of the task. Consequently most of the value is lost. When research is completed there usually is a psychological collapse which delays following through to the application of the idea. It is to be expected that practical men will be skeptical toward the results, and difficulty often arises in getting the market and the world in general to adopt the results of research.

* * *

Engineers Extend Co-operation to R. F. C.

LOANS applied for under the self-liquidating provisions of the emergency relief and construction act aggregate more than a billion dollars, according to the American Engineering council, which is organizing the nation's engineering profession to co-operate with the Reconstruction Finance Corp. in speeding construction projects contemplated by Congress.

Engineer activity is under way throughout the country following the appointment of 37 engineers as members of the advisory committees of the corporation's loan agencies. From now on, it is believed, the work of each of these agencies will be co-ordinated so effectively that the task of the engineers' advisory board of the corporation at Washington, to which all applications are submitted for final engineering approval, will be materially simplified.

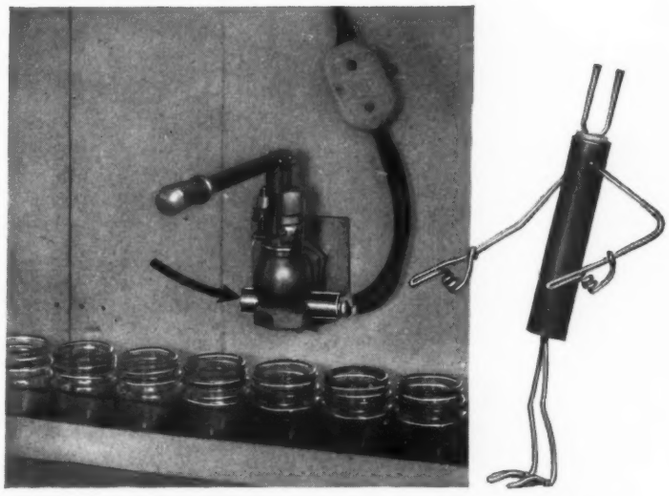
Engineering assistance, it is planned, will expedite the disposal of applications already made and encourage a large number of new undertakings, particularly those involving small loans. Self-liquidating loans totaling $134,633,500 have already been approved. Engineers express confidence that there soon will be a large increase in loans of this type, with a resultant sharp gain in employment and manufacturing activity before winter is far along.

* * *

Report on Extended Lubrication Research

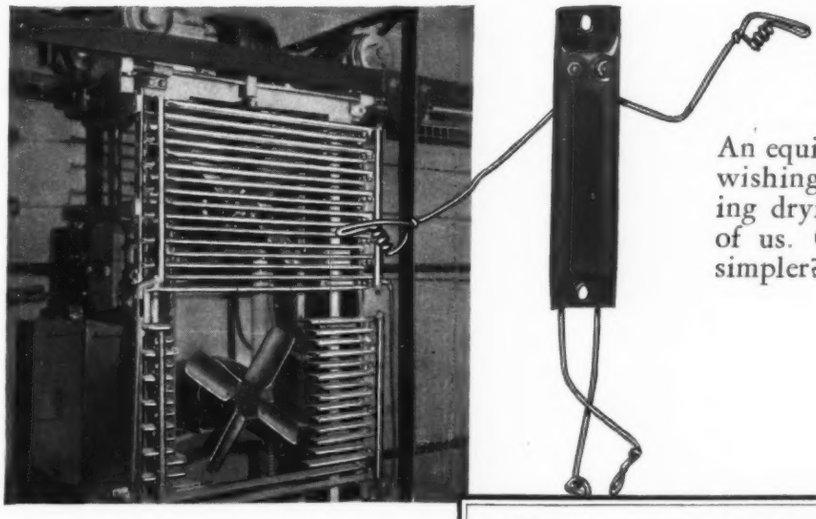
CHEMICAL mechanism of lubrication was discussed by William F. Parish and Leon Cammen at the recent annual meeting of the American Society of Mechanical Engineers in New York. Their introductory paper on the subject of the mechanism of lubrication, ab-

Let These Handy Heating Helpers Solve Your Every Small Heating Job



I am *"Spot"* (a G-E cartridge-type electric heating unit)

See how I solved a problem for this pharmaceutical manufacturer. This valve is used to fill jars with ointment. A spot of electric heat inserted behind the valve keeps the ointment at proper viscosity. Could anything be simpler?



I am *"Strip"* (a G-E electric strip heater)

An equipment manufacturer wishing to heat this traveling drying system, used 24 of us. Could anything be simpler?

EACH of the dozens of items in the G-E line of small electric heating units and devices is designed to meet a special small heating problem. All of this equipment has been put in one valuable mail-order catalog. This coupon will bring you your copy.

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GENERAL ELECTRIC

stracted in the August issue of MACHINE DESIGN, attracted attention not only in this country but abroad as well. In the new paper the authors point out that while mechanical engineers design lubrication systems, lubrication as such is essentially a chemical phenomenon.

Explanation in terms of electric fields is given as to why excessive heat is developed when a dry shaft runs in a dry bearing. New criteria for testing of lubricants is established in the paper which also lays a practical foundation for future research in the field of manufacture of lubricating oils and their application in modern machinery.

The practical part of the paper discloses for the first time how during the World war the lubrication of Liberty engines and other aircraft was improved tremendously by a retreated lubricant. The same lubricant later was tested in diesel engines, automobile and special equipment, giving unusual results. These data are being submitted in view of the fact that they seem to substantiate from a practical point of view the phenomenon described. This is of more than ordinary interest as it indicates the possible development of lubricants of much greater efficiencies.

* * *

Farm Machinery Exports Gain, Output Drops

FARM implement exports are showing a steady rise in their relation to production in this country, from 10 per cent in 1920 to 27 per cent in 1931, a depression year. In 1929 American production of farm implements entered the 10 per cent class in export trade. While output declined during the next three years the percentage of exported implements increased to 12 per cent during 1921, to 13 per cent in 1922 and to 15 per cent in 1923. During the following four years these exports remained fairly constant or around 20 per cent for each year. By 1930 foreign countries took 24 per cent and last year when production dropped to its lowest level, the export trade in these implements rose to 27 per cent of American production.

* * *

Educational Work in Welding Increases

INDICATIVE of the ever-increasing field for engineers versed in welding is a new combined practical and theoretical one-week course in designing for welded construction. This opportunity is being offered by John Huntington Polytechnic institute, Cleveland, in co-operation with the Lincoln Electric Co. The course will be repeated several times during the winter season.

Restricted to 30 men who must be graduate engineers or have equivalent practical experience, the course covers a week's intensive work, the six days being spent in the Lincoln operator's training school. Lectures on designing for arc welded construction will be given in the evenings at the Huntington institute.

* * *

Free Trade in Ideas Hurdles Tariff Walls

TO MAKE available to manufacturers in one country, devices, processes and patents that have proved successful in other countries, offices now have been opened in New York by Amerika-Interessen Inc., organized as the American unit of A. G. Fuer Amerika-Interessen, operating also in Berlin, Paris and London. The organization virtually is sponsoring free trade in ideas to surmount the tariff barriers which now gird the world.

According to the statement made by Botho Lilienthal, president of the corporation, the newly created unit will negotiate agreements covering production and marketing rights for manufacturers who wish to augment their incomes by obtaining business abroad but who can not do so by exports. This is accomplished by issuing licenses on a royalty basis or by the outright sale of manufacturing and marketing rights for the country involved. International trade of this type helps the unemployment situation of the country into which new ideas are introduced because it often opens new lines of manufacture in such countries and also is of financial benefit to companies in the country from which the ideas are exported.

* * *

Industrial Drama Gets Hearty Reception

WELL deserved comment has been invoked by an innovation in convention programs —the industrial drama presented at the recent thirty-third annual meeting of the International Acetylene association in Philadelphia. Titled "The Prosperity Process," it was enacted before 2500 guests and suggests one way of balancing top heavy technical programs.

The play deals with the experience of a typical manufacturing company during the present depression. For three years scarcely little business has been booked and then suddenly an order for 10,000 parts for an air conditioning system is received. The hero is the oxyacetylene process which affords the management not only means to repair its down-at-the-heels equipment with minimum expense but also a production tool for mass manufacture. So satisfactorily is the order executed that a repeat order for an even larger number of parts is received. Novelty of the industrial drama holds an appeal for thousands who have tired of meetings overburdened with ordinary technical sessions.

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Infinite speed control! Speed control for the machines you build that makes *any* desired speed *instantly available* to the operator. Speed control that effects speed changes *smoothly*, POSITIVELY—without jerks or "steps"—and without stopping the machine or interrupting production. Speed control that permits close gradations in speeds—even to fractions of revolutions per minute.

How this *accurate* speed control can be incorporated as standard equipment on production machines is fully described and illustrated in REEVES Catalog No. 99. This book has been compiled by REEVES engineers who have helped incorporate infinite variable speed control into more than 670 different kinds of machines as standard equipment.

Sales success is being largely determined in design departments these days. Performance must be so improved that buyers *can't* say "No." REEVES can help you. . . . Send for a copy of the 74-page REEVES catalog.

PARTIAL CONTENTS

List of 81 different types of production machinery in which the REEVES Variable Speed Transmission is incorporated as standard equipment.

Engineering data in convenient form for reference—tables for selecting correct size and class (speed range) of REEVES Transmission for any machine application. Complete dimension diagrams of various REEVES Designs, efficiency charts, etc.

A comprehensive description of the construction and operating principle of the REEVES Variable Speed Transmission.

A pictorial presentation and description of the extensive line of REEVES Transmissions—designs and controls developed to meet the specific requirements of hundreds of industrial machine and manufacturing processes.

A modern, complete treatise on Automatic Speed Regulation, describing numerous examples of precise speed control effected entirely automatically.

WHEN MACHINES are equipped with the REEVES Variable Speed Transmission, their speeds can be varied *instantly and accurately* to match any of the following conditions:

The processing of many different sizes of products on one machine; changes in composition or in the characteristics of material in process; variance in temperature or atmospheric conditions; changes in the complete production schedule; need for increasing or decreasing "cycle" operation of machines; variances in the number or skill of machine operators; changes in machine operation occasioned by new products, new designs or new sequence of processing.

REEVES Standard Horizontal Enclosed Design —One Unit from the *Complete* REEVES Line.

REEVES
VARIABLE SPEED TRANSMISSION

REEVES PULLEY COMPANY, COLUMBUS, INDIANA

Please send us a copy of 74-page catalog H-99.

NAME..... COMPANY.....

ADDRESS.....

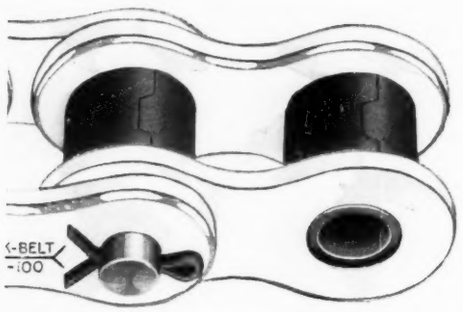
NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

New Chain Resists Corrosion

SIDE bars of the new roller chain brought out by Link-Belt Co., Chicago, are especially treated to combat corrosion. This treatment gives them the appearance of silver. Silverlink roller chain shown herewith is made in all sizes from $\frac{3}{8}$ to 2½-inch pitch, and in single or multiple widths. It is available with wheels for any horsepower, also with conveying attachment links in wide variety. Complete drives are stocked in sizes up to 225 horsepower, in speed ratios of from 1:1 to 8:1.

Construction features include: Side bars of

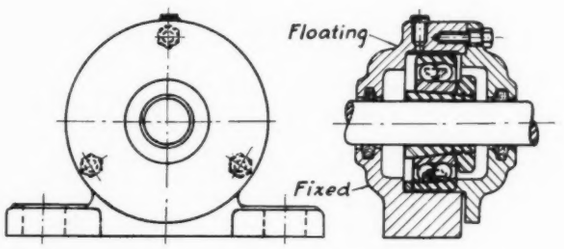


Side bars of new chain are especially treated to assist in resisting corrosion

alloy rolled steel heat treated for strength and toughness, and especially treated to resist corrosion; nickel steel case-hardened pins, detachable type with cotter or furnished riveted; solid steel case-hardened bushings; and alloy steel heat treated rollers.

Pillow Block Pedestals Are Compact

ADAPTABLE to all average industrial requirements, the new line of unit pedestals for pillow blocks announced by Norma-Hoffman Bearings Corp., Stamford, Conn., is available in sizes to fit standard shafting in nominal inch as well as sixteenth diameters from 15/16 to 3½ inches. The ball bearings in the unit, shown herewith, are the standard double row, self-aligning type with adapter sleeve manufactured by the company. The pedestals have capacity for a large volume of lubricant with fittings for replenishing as needed. Protecting felt seals prevent escape of lubricant along the shaft. These pedestals may be had with the bearings

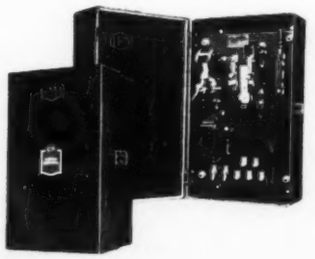


Protecting felt seals prevent escape of lubricant on pillow block pedestals

either floating or fixed in the housing. In the latter case suitable distance pieces are furnished for clamping the outer ring.

Starter Designed for Severe Service

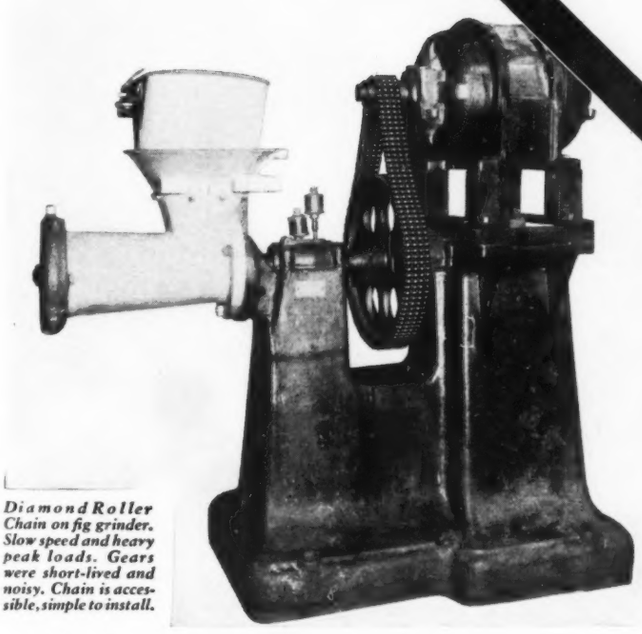
DESIGNED for use on equipment employing motors rated 15 horsepower and below, where starting duty is severe, a new across-the-line type, automatic motor controller has been brought out by Cutler-Hammer Inc., 328 North Twelfth street, Milwaukee. The unit, shown herewith, employs a simple adjustable means of timing to allow the field current of the motor to build up to full strength before the circuit to the armature is closed. This feature protects and saves the motor by cutting down the current inrush about 50 per cent. Over-



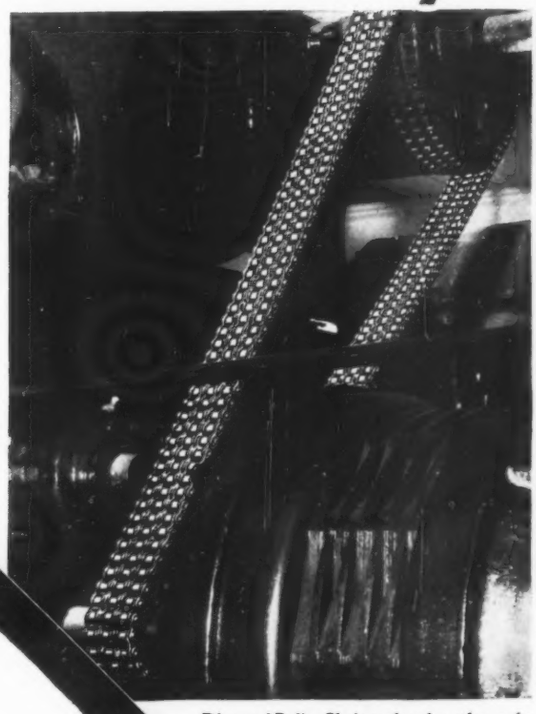
Controller is designed for equipment where starting load is unusually severe

Use Them Both Ways

1. On Your Motor Drives



Diamond Roller Chain on fig grinder. Slow speed and heavy peak loads. Gears were short-lived and noisy. Chain is accessible, simple to install.



Diamond Roller Chain replaced another make of chain on the oven conveyor drive—has already lasted twice as long.

2. On Machines You Build

IN plant operation—in design (if your product is a machine) Diamond Roller Chain is an almost universal answer to your drive problems.

Diamond Drives incorporate the roller-bearing principle—maintain over 98% efficiency. They are positive—no slippage,—no variation in speed-ratios. Initial and maintenance costs are low.

On machines you build, Diamond Chain is a tremendous help in design because of flexibility of application. They run over sprockets or under them in either direction, between long centers or short. They can be installed or removed in a few minutes without dismantling the machine.

The coupon below names two interesting booklets—either one or both will be sent on request . . . without obligation.

DIAMOND CHAIN & MFG. CO.
435 Kentucky Ave., Indianapolis, Indiana
Offices and Distributors in Principal Cities

This Diamond on every link identifies the Diamond Drive

DIAMOND ◇ DRIVES
for Every Industrial Need

Quiet — Clean — More Compact per H. P. Transmitted

DIAMOND CHAIN & MFG. CO.
435 Kentucky Avenue, Indianapolis, Indiana

Gentlemen: Please send me a copy of Booklet 102-B, *"Reducing the Cost of Power Transmission,"* and of Booklet 104-A *"Simplifying and Improving Machine Design."*

*Name*_____

*Firm*_____

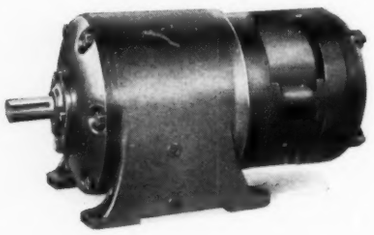
*Address*_____

*City*_____ *State*_____

load protection for the motor is furnished if desired. The starter, which is designed for direct current use, is mounted in a dust tight split enclosing case.

Geared Motors Are Available

FOR use where low-speed drives are required, Allis-Chalmers Mfg. Co., Milwaukee, has developed a motor reduction unit which consists of a standard round frame type motor mounted directly on the gear reducer housing. Thus a compact unit is formed. Helical gears are used, permitting high efficiency and quiet operation. Standard speeds at the power take-off are from 3.02 to 380 revolutions per minute, but lower speeds can be provided; 6.08 revolutions per minute is obtained with the use of a 1750 revolutions per minute motor.



Many types of motor can be employed with new line of motorized speed reducers

The bearings supporting the gear drives are ball or roller type. Lubrication is automatic and continuous, insuring an adequate supply of lubricant at all times. Standard units are arranged for floor mounting, while units can be supplied for wall, ceiling or vertical mounting. Any type of motor may be supplied including standard squirrel cage induction, wound rotor, enclosed fan cooled, explosion proof or direct current.

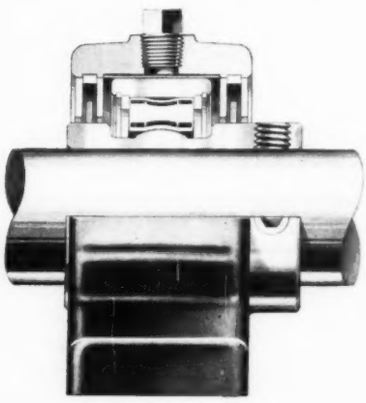
Nickel-Clad Steel Finish Improved

A NEW finish has been developed for nickel-clad steel, a hot rolled bimetal made up of a light layer of pure, solid nickel bonded to a heavy layer of flange quality steel, by International Nickel Co., and Lukens Steel Co., Coatesville, Pa. With this finish, classified as hot rolled and cleaned, the steel is free from the brown nickel oxide on the nickel side. This oxide is formed during the rolling of the bimetal at high temperatures and is somewhat similar to the finish on standard hot rolled steel plates.

While the oxide type of finish will continue to be produced, due to the corrosion resistant properties of the nickel oxide, the new finish has been planned for the many uses where a cleaner appearance will be beneficial. The cleaning process gives the nickel a matt appearance nearly white in color. This hot rolled and cleaned finish, however, should not be confused with the bright, lustrous surface of cold rolled and full finished solid nickel sheet, where refinement is obtained by cold rolling. Nickel-clad steel now is available in rectangular plates and circles in a wider range of sizes than heretofore.

Roller Bearings Are Self-Aligning

A NEW line of single row, self-aligning roller bearings is being offered by Shafer Bearing Corp., 621 South Kolmar avenue, Chicago. A single row concave bearing is used with roller operating between a straight outer race and a convex inner race. This design assures sufficient radial load capacity with provision for the limited thrust capacity needed in applications having moderate loads.



Self-aligning bearing compensates for misalignment due to inaccuracies in machining or shaft deflection under load

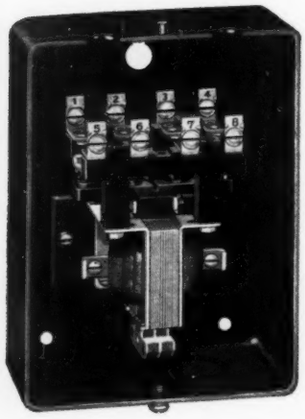
Self-alignment is obtained in the bearing itself, thus compensating for misalignment due to inaccuracies in machining or shaft deflection under load. The bearing is of the full roller type, a retainer being omitted. Thrust is taken by means of hardened and ground thrust plates. In addition to the pillow block, shown herewith, the light duty bearings are available in flange units, hanger boxes and take-up units for shafts from 9/16 to 2-3/16 inches inclusive.

Announces Improved Contactors

SOLENOID operated contactors in a new line for alternating current applications requiring a remote control switch have been announced by Allen-Bradley Co., 1311 South First street, Milwaukee. The contactors, shown herewith, are made in single or multiple pole con-

struction with silver-to-silver contacts up to and including an 8-pole unit for two-wire control.

Contacts are supported on self-contained insulating cross pieces and require no slate panels,

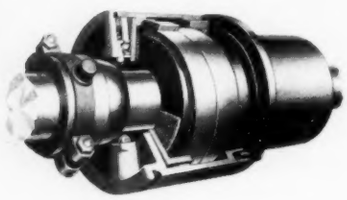


Contactors are made in single or multiple pole construction with silver-to-silver contacts

so they can be mounted directly on metal panels or machines. The operating coils can be furnished for any frequency in voltage—6, 12, 24, 110 and 220 being standard.

Cut-off Coupling Is Disk Actuated

DRIVING and driven sections of the new spiral friction cut-off coupling introduced by Kinney Mfg. Co., 3541 Washington street, Boston, are held in line by a ball guide bearing. The driving mechanism in the unit, shown herewith, consists of a spiral band contracting on to a driv-



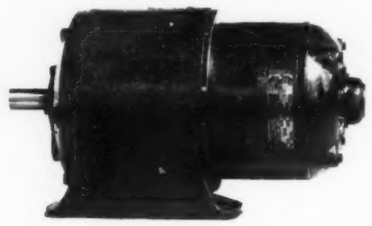
Cut-off coupling can be furnished for either dry or lubricated friction surfaces

ing hub, the band being actuated by a flat friction disk faced with asbestos. Power is transmitted by the spiral band. The sole duty of the friction disk is to contract the spiral. Shifter sleeve is of the cone type, while all parts of the shifter mechanism which are subject to wear are heat treated, hardened steel.

Reducer Uses Any Type of Motor

MOTORIZED speed reducers which may employ nearly any type of motor have been placed on the market by Louis Allis Co., Milwaukee. The motor and speed reducer are combined into a self-contained unit which may be mounted easily on the machine. Ratings available are ¾ to 75 horsepower with output speeds of 4 to 400 revolutions per minute.

These units can be furnished with motor characteristics and style of mounting best suited to each application. The integral style, shown herewith, in which the end bell is removed and the motor close-coupled to the gear casing, is most common where an open motor or an enclosed nonventilated motor is employed. The flexible style, in which the entire motor without any change is mounted on the gear casing,

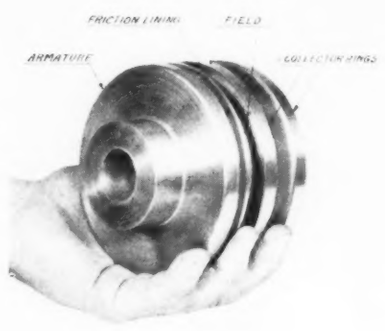


Automatic and continuous lubrication is supplied on motor reduction unit

is furnished where conditions require an explosion proof, splash proof or other protected type of motor. Either style can be furnished to provide normal starting torque, high starting torque, high slip, adjustable speed, multispeed or other desirable characteristics that can be built into separate motors.

Magnetic Clutch Is Extremely Small

HIGH torque with compact construction is available with the magnetic clutch built by Magnetic Mfg. Co., Milwaukee, which is only 5

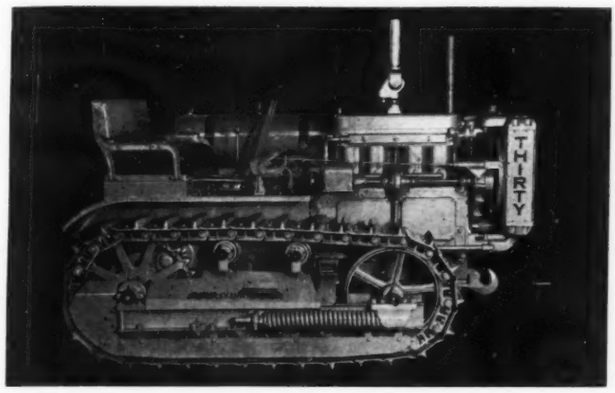


Small magnetic clutch embodies few parts, yet has unimpaired efficiency

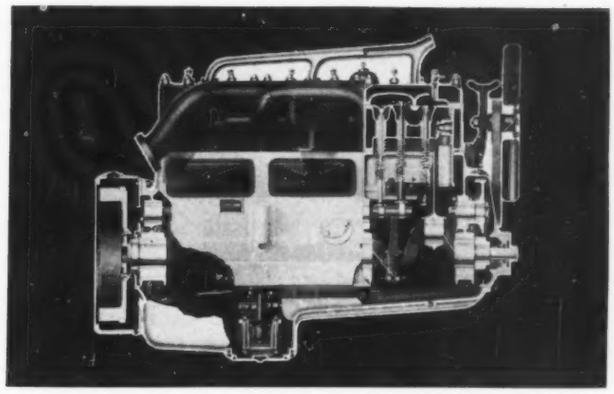
inches diameter, yet develops 500 pounds inches pull-out torque. The clutch, shown herewith, is simple in design and embodies few parts. Electrical and mechanical efficiency are not impaired by its simple construction. Collector rings are located on the outside diameter, staying well within the diameter of the clutch. The

WHAT'S YOUR JOB?

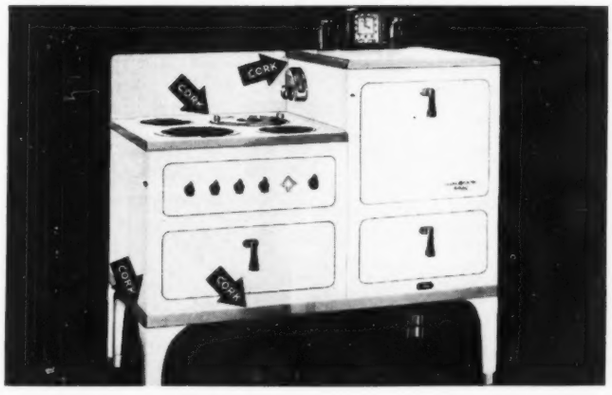
WE ALTER THE CHARACTERISTICS OF CORK TO FIT YOUR NEEDS



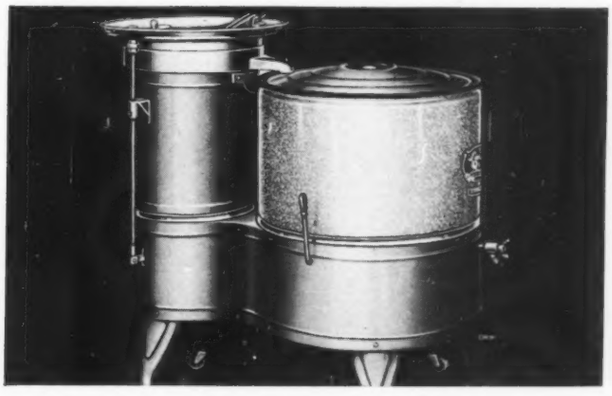
OIL SEALS . . . Caterpillar's problem was to keep water, sand, dust from the track rollers and to keep in the oil. In field and forest, swamp and desert those bearings have to be protected against grit and lubricated without leakage. Armstrong's Cork was chosen because of its unique combination of properties. Resilience, compressibility, and resistance to liquid penetration are *controlled* according to the needs of the service.



GASKETS . . . No oil can ooze through! The Waukesha Engine, designed for heavy duty truck and bus work, is sealed at vital points with Armstrong's Cork. In this sort of combustion engine, gaskets must be leakproof, and must fit accurately. Armstrong's Cork fills both requirements . . . which accounts for the widespread use of these gaskets by the Waukesha Motor Company and other manufacturers of engines and automobiles.



CUSHIONING . . . How to bolt porcelain to porcelain without chipping? That question is answered by strips of Armstrong's Cork in the General Electric Hotpoint Range. They cushion the joints and prevent chipping or cracking when bolts are drawn tight for a rigid assembly. Armstrong's Cork *keeps on cushioning*, won't lose its resilience.



FRICTION DRIVE and BRAKE . . . After testing various materials, Grinnel Washing Machine engineers selected Armstrong's Cork as the most efficient material for transmitting power and for braking. A cork friction disc drives a cast iron wheel. A cork brake disc stops the machine. Armstrong has special compositions for such services.

HOW ABOUT YOUR PROBLEM!

Our Industrial Sales Engineers can help you with your problems of driving, braking, cushioning, sound deadening, insulation, or sealing. Armstrong's Cork can be shaped and controlled to your specifications. Outline your problems and send a blueprint, if possible. Armstrong Cork & Insulation Company, Industrial Sales Division, 918 Arch Street, Lancaster, Pennsylvania.

Armstrong's (A) *Product*

Armstrong's
CORK
MADE TO YOUR SPECIFICATIONS

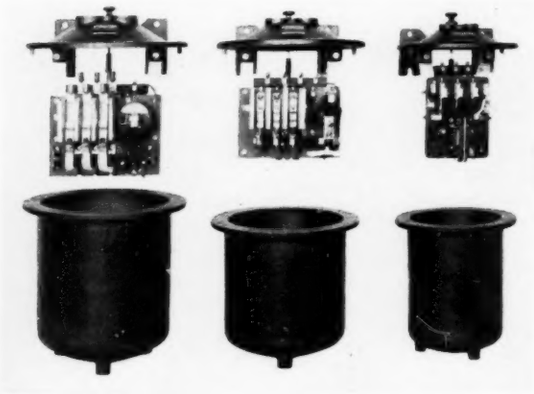
unit is a true single disk clutch in that it has only one friction or wearing surface. Current consumption is approximately 100 watts. Length is 3¾ inches.

Magnetic Switches Are Protected

A LINE of full voltage magnetic switches built to the standards of the Underwriters' laboratories for industrial control equipment for use in Class I, Group D hazardous locations has been announced by General Electric Co., Schenectady, N. Y. These switches, shown herewith, are weatherproof as well as being suitable for use in corrosive atmospheres.

The devices consist of standard magnetic switches with special operating coils and contact tips for operation under oil, and an oil immersed temperature overload relay. The enclosure is explosion proof having been designed to meet Underwriters' requirements for air-break switches, and the oil is used only to protect the magnetic switch and the overload relay against corrosive fumes.

For use in connection with these switches, a push button station also meeting specifications has been developed for remote control in hazardous locations. This new line of devices supplements the similar line of explosion proof switches which have air-break contacts.



Magnetic switches have been approved for use in hazardous locations

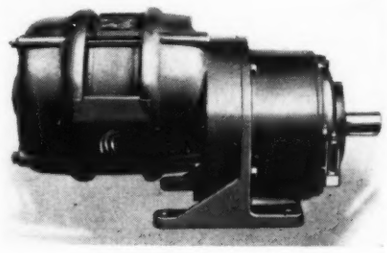
Coupling Provides Infinite Speeds

APPLICABLE for installations such as pumps and fans, the hydraulic coupling being marketed by American Blower Corp., Detroit, gives an infinite number of driven shaft speeds ranging down to about 20 per cent of the motor speed. The unit allows the motor to be started under practically no load conditions.

Power is transmitted by the kinetic energy of a liquid discharged by the impeller directly against the vanes of the runner. A continuous circulation of oil takes place from the coupling through the scoop tube to the gravity tank and back to the coupling. There are no packed joints or high pressure fittings on the unit.

Develops Motor Reduction Unit

NO MOTOR coupling is used on the gear reduction units built by Ideal Electric & Mfg. Co., Mansfield, O., as the high speed gear is mounted directly upon the motor shaft. These units, shown herewith, are available in all gear ratios from 2.09:1 up to 376:1, giving output speeds of from 4.7 to 861 revolutions per minute using the standard 1800 revolutions per minute motor.



Two, three or four-speed motors can be supplied for use with line of geared motors

For reduction ratios up to about 6 to 1, the reducer consists of a single stage helical gear unit. For higher ratios up to and including 24.5 to 1, a two-stage helical gear reducer is used. For reduction ratios of 30 to 1 and higher one stage of helical and one stage of heliocentric gears gives the required reduction. The units employing heliocentric gears have the motor hung on the reducers, while other units have the reducer hung on the motor.

Geared motors are supplied in all horsepowers from ¾ to 20. Either open or enclosed type motors are furnished, for 2 or 3-phase alternating current or for direct current. Two, three the reducer hung on the motor.

Bonds Stainless and Carbon Steels

STAINLESS steel and plain carbon steel are combined in the ingot and rolled together to form the new product of Allegheny Steel Co., Brackenridge, Pa. The resulting material is a solid sheet of plate, 20 per cent of the thickness of which is 18-8 chrome nickel steel and the remainder mild steel. An advantage of the com-

Patronize Your *Udylite* Jobber - -

This is the sign which stands for quality rust protection and quality service. It assures you that your corrosion problems will be given the prompt and efficient attention of rust proofing specialists.

From New England to the Pacific Coast, you see this sign—the identification of the authorized Udylite jobber. There are approximately one hundred of these authorized jobbers located in all principal industrial centers. They serve the needs of thousands of plants manufacturing metal products.

Be sure of satisfaction and refer your rust proofing requirements to an authorized Udylite jobber who has a reputation for honesty, trustworthiness and efficiency to sustain. A glance at the list of jobbers will give you the name of the one nearest you. Call him and obtain Udylite-Cadmium—the finish that not only protects but also beautifies.

UDYLITE PROCESS COMPANY

3937 Bellevue Avenue Detroit, Michigan

New York City	Chicago	San Francisco
30 East 42nd Street	205 Wacker Drive	1114 Sansome Street

AUTHORIZED *Udylite* JOBBERS

Calif.,	*Glendale,* Industrial Plating Co.
	Los Angeles, Cadmium & Nickel Plating Co.
	Franz Mch. Tool & Die Wks.
	Pacific Enameling & Pl't'g Co.
	Western Galvanizing Co.
	Oakland, Progressive Pl't'g & Enameling Wks.
	Pasadena, Crown City Plating Wks.
	San Diego, Universal Plating Wks.
	San Francisco, Golden West Plating Wks.
Colo.,	*Denver,* Sachs Lawlor Co.
	Pueblo, Rocky Mountain Pl't'g Wks.
Conn.,	*Hartford,* Nat'l Sherardizing & Mch. Co.
	Plainville, Plainville Electro Plating Co.
Ill.,	*Aurora,* Aurora Plating Co.
	Batavia, Challenge Co.
	Chicago, Electro Galvanizing Co.
	Great Lakes Plating Co.
	Vacuum Can Co.
	Western Rustproof Co.
	Peoria, Central Plating & Fixture Co.
	Quincy, Quincy Enameling & Pl't'g Co.
Ind.,	*Elkhart,* Chicago Telephone Supply Co.
	Ideal Plating Co.
	Evansville, Millers Plating Wks.
	Fort Wayne, Wayne Metal Protection Co.
	Goshen, Standard Plating Wks.
	Kokomo, Midwest Rustproofing Co.
	Muncie, Kiser Plating Co.
	Richmond, Lahman Plating Wks.
	South Bend, Swanson Plating Wks.
Iowa,	*Davenport,* Iowa Silver Plating Wks.
	Waterloo, Chamberlain Corp.
Ky.,	*Louisville,* Kentucky Plating Co., Inc.
	Reliance Plating Wks.
Md.,	*Baltimore,* D. R. Holmes
	Frederick, Everedy Co.
	Middle River, Glen L. Martin Co.
Mass.,	*Boston,* Rust Proofing & Metal Fin. Corp.
	Springfield, T. J. Murray
Mich.,	*Ann Arbor,* Barnard & Hammond
	Bay City, Leo D. Goddeyne
	Detroit, Detroit Plating Industries
	Parker Rust Proof Co.
	White Rust Proof Co.
	Flint, Standard Electroplating Co.
	Grand Rapids, Grand Rapids Plating Co.
	Valley City Plating Co.
	Jackson, Chromium Plating Corp.
Minn.,	*Minneapolis,* Superior Pl't'g & Rustpr'fing Co.
	St. Paul, Minnesota Plating Wks.
Mo.,	*Kansas City,* Bar-Rusto Corp.
	St. Louis, St. Louis Rustproofing Co.
N. H.,	*Nashua,* Nashua Brass Co.
N. J.,	*Newark,* Pyrene Mfg. Co.
N. Y.,	*Buffalo,* Keystone Chromium Corp.
	Marlette Plating Co.
	Union Polishing & Pl't'g Co.
	No. Syracuse, Saline Plating Wks.
Ohio,	*Akron,* Nat'l Sherardizing & Mch. Co.
	Alliance, Alliance Mfg. Co.
	Bryan, Ohio Plating Co.
	Bucyrus, Bucyrus Plating Wks.
	Cincinnati, Stolle Corp.
	Cleveland, Wagner Rustproofing Co.
	Columbus, Columbus Metal Prod., Inc.
	Dayton, St. Clair Plating Co.
	Massillon, Massillon Pl't'g & Rustproofing Co.
	Minerva, Liberty Bell Mfg. Co.
	Toledo, Gerity Whitaker Co.
	Jas. E. Nagle & Son, Inc.
	Wm. Whitaker & Son
	Warren, Wetzel Plating Co.
	Wellington, Cleveland Steel Products Co.
Okla.,	*Tulsa,* Tulsa Plating Wks.
Ore.,	*Portland,* California Plating Wks.
Penna.,	*Erie,* Erie Plating Wks.
	Lancaster, K D Mfg. Co.
	Philadelphia, Philadelphia Rust Proof Co.
	Pittsburgh, Walter E. Hague & Son, Inc.
	Wilkes-Barre, Johnson Eng. & Mfg. Co.
R. I.,	*Providence,* General Fittings Co.
Texas,	*Cuero,* H. G. Keseling Sheet Metal Wks.
	Dallas, Dallas Mfg. & Plating Co.
	Dallas Silversmithing Co.
	Fort Worth, Axtel Co.
	Houston, Dixie Electro Plating Co.
	San Antonio, Southern Plating Co.
Va.,	*Norfolk,* Whaley Aircraft & Eng. Co.
Wash.,	*Seattle,* Eagle Plating Wks.
	P-G Emblem Co.
	Whitehouse Plating Co.
Wisc.,	*Beloit,* Rock County Buick Co.
	Madison, Capitol Plating Machine Co.
	Milwaukee, S. K. Williams Co.
	Racine, Shephard Plating Co.

(CADMIUM *Udylite*)

bination sheet is its comparative ease of fabrication, as the physical characteristics of the sheet approach more nearly those of the mild steel which makes up 80 per cent of its thickness.

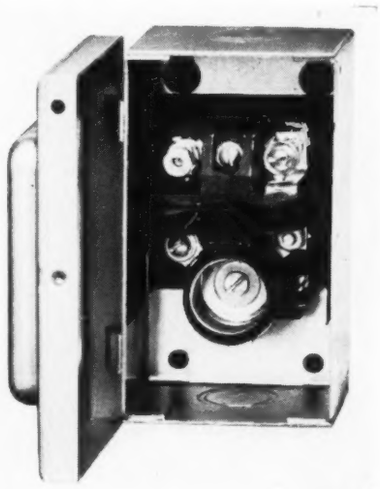
The metal clad plate, licensed under Ingersoll patent No. 1,868,749, is said to have an indissoluble bond between the two metals. It can be applied wherever a corrosion resisting surface is required, or where the appearance of the stainless steel is desired.

Front-Operated Switch Is Compact

ESPECIALLY designed for resale machinery manufacturers, the compact, front-operated switch introduced by Switch and Panel division, Square D Co., Detroit, is only 5 3/8 inches high by 3 1/8 inches wide and 2 3/4 inches deep yet it has a capacity of 30 amperes or 1 horsepower at 125 volts. The unit, known as Catalog No. 90211, is a two-pole switch with one fuse, one blade and solid neutral.

Front operation of the switch, shown herewith, is obtained by the special design; the switch is one of the conventional knife blade construction, but embodies a small disk rotating between two spring copper blades. This feature permits a small sized cabinet and convenient operation without the necessity of providing for blade swing or a side operating handle.

Considerable attention has been given to the appearance of the switch. Standard finishes are bronze or black, but other colors may be had to match the machinery or equipment upon which it is to be mounted.



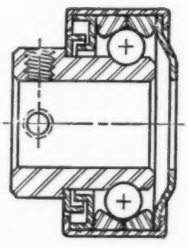
Compact, front-operated switch is designed especially for resale machinery manufacturers

From THIS to THIS

AND ALL SIZES IN BETWEEN

WE MAKE bearings for every industry and every purpose. We can provide you with stock bearings, or bearings made to your own B.P. specifications. Bearings of various sizes for every type of installation. In other words, The Schatz Manufacturing Co. may be considered as "bearing headquarters".

Our Engineers are glad to assist in suggesting methods for improving installations. Long experience enables us to solve the most difficult installation problems.



"COMMERCIAL" Annular Ball Bearings have a larger number of balls which means additional wear and strength. Speeds up to 2500 R.P.M. Dual thrust capacity and most important of all—moderate cost for quality performance.

Write for Information, Price Lists and Samples

THE SCHATZ MANUFACTURING CO.
Poughkeepsie, New York
Detroit Sales Office: 2608 Book Tower; Chicago Sales Office: 120 N. Peoria St.

"Commercial" BEARINGS

*

Supplementing Efficiency with Good Looks

(*Concluded from Page* 25)

which the checks are withdrawn, and the single word "Checks" was debossed across the front of the casting, with the letters lacquered in vermillion to give them attention value. The main body of the case was finished in a crinkled lacquer of French gray, although this method allows a choice of color in order to meet the requirements of individual purchasers.

We thus have a simple and logical housing costing no more to produce than the old one and having in addition, a number of decided practical advantages. The form is simple but striking, and its scheme of French gray with notes of chrome plate and black at top and bottom and a single, striking note of vermillion, is individual but not garish. It has met with immediate success.

Strict Co-operation Essential

In both these instances—as in many others that might be cited, from thermometers to 16-cylinder motor cars—the results have been achieved by working closely with the engineers responsible for the development and manufacture of the machines. In almost every instance the work of the industrial designer consists in outlining to these technical men the object to be achieved and relying upon them to discover a means for arriving at that end. New requirements in design often raise serious problems. Sometimes these cannot be surmounted and it is necessary to revise the design in a more practical but equally attractive manner. Very often the difficulties can be overcome. In any case, mutual confidence and co-operation are essential. The designer and the engineers must be able to sit down together and iron out their problems as they arise, and they must sit by the bedside of the new-born infant and watch over it with ceaseless vigilance until it is ready to go out into the world.

In this way of working there is no excuse for an industrial designer remaining merely a meddlesome outsider who makes life more difficult for the already overworked engineering staff. If he has a wholesome respect for their knowledge and their difficulties and they have a reasonable amount of confidence in his practical common sense as well as his designing ability, they can work together in complete accord and with highly satisfactory results to the great benefit of the products for which they share a responsibility.

Quality
IN THE PRICE CLASS

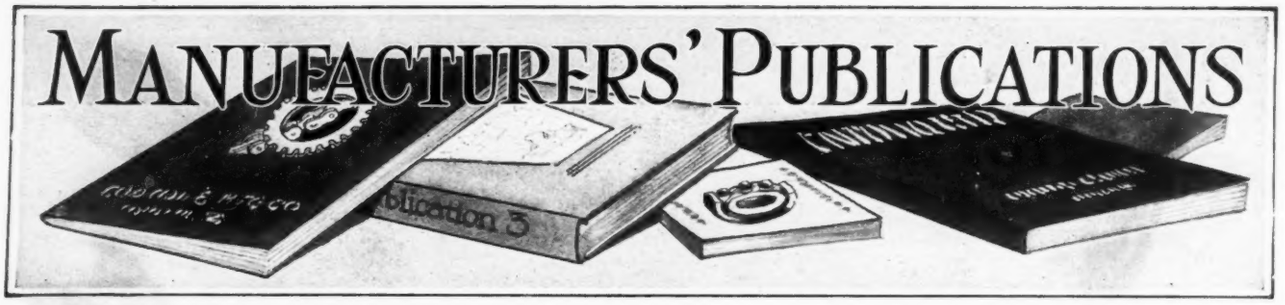
The demand today is not for price or quality alone *but for quality at a price* ... The model E E and E E X motors illustrated meet this exacting requirement .... These motors are built to the well-known Dumore quality standards. They develop 1/75th H. P. and are of the universal type with balanced armatures. They are enclosed in a tightly-fitting die cast housing and are equipped with self aligning bearings in addition to possessing other typical Dumore quality features ... Investigate the application possibilities of these two models! .... Send us a print of your requirements. The Dumore engineering staff may be of assistance to you in the application of either of these two Dumore models to your product.

DUMORE COMPANY
100 16th Street Racine, Wis.

Send for bulletins which fully describe the Dumore Double Gear Reduction Units. These bulletins contain complete technical data regarding reductions, shaft speeds, dimensions and etc.

DUMORE
FRACTIONAL HORSEPOWER
MOTORS

MANUFACTURERS' PUBLICATIONS



Publications listed in this section may be obtained by engineers responsible for design from the manufacturers of the products or through MACHINE DESIGN

ALLOYS (STEEL)—Stainless steels and their uses are covered in a new 20-page bulletin of Electro Metallurgical Co., New York. The booklet describes the advantages of the material and its applications, and presents photographs showing its use in many industries.

BEARINGS—Catalog No. 12 of Shafer Bearing Corp., Chicago, presents complete information on the entire line of self-aligning units manufactured by the company, including the new line of single row bearings recently announced. The catalog gives sizes, dimensions, load ratings and similar data.

CONTROLS (ELECTRICAL)—Square D Co., Detroit, has issued a bulletin on its Catalog No. 90211 switch, a small, compact, front-operated switch for resale machinery manufacturers.

DRIVES—B. F. Goodrich Co., Akron, O., has published a 4-page booklet on its Highflex belting entitled "Lubricated with Rubber." The booklet points out how the rubber on the belt acts as a lubricant, its elasticity allowing the belt plies to slide over each other.

DRIVES—Link-Belt Co., Chicago, is issuing catalog No. 1457 on its new Silverlink roller chain which has side bars especially treated to assist in resisting corrosion. This treatment gives the side bars the appearance of silver. The chain is available in all sizes from ⅜ to 2½-inch pitch.

DRIVES—Philadelphia Gear Works, Philadelphia, has prepared a new catalog on its line of MotoReduceRs in the horizontal and vertical types. The catalog describes the equipment, gives dimensions, complete tables of horsepower ratings and speed reductions from ½ to 75 horsepower, and a table and formulas for maximum overhung load.

DRIVES—Universal Gear Corp., Indianapolis, has prepared a 16-page bulletin on its line of motorized reducers which are available in horizontal or vertical types and fractional and integral horsepowers. The bulletin describes the line, supplied in all ratios, gives features of design, dimensions and engineering information. Heliocentric reducer elements are used in ratios above 25:1.

MATERIALS (COMPOSITION)—Dilecto, a laminated synthetic material manufactured by Continental-Diamond Fibre Co., Newark, Del., is presented in a 40-page booklet recently issued by the company. Besides a general description, applications, specifications and similar information, the booklet includes a table of standard grades and sizes of the material and their properties. Another table gives a comparison of the properties of hard rubber, vulcanized fiber and synthetic phenol resins.

MOTORS—A complete line of motors of from 1/10 to 10 horsepower manufactured by the Brown-Brockmeyer Co. Inc., Dayton, O., is presented in two new bulletins of the company. Points in design and manufacture are described in detail, while tables give electrical data, horsepowers, and similar information on each of the types manufactured.

PUMPS—A new design of rotary displacement pumps for oil service is described in a bulletin of De Laval Steam Turbine Co., Trenton, N. J. These pumps require no valves, no pilot gears and no separate bearings. There are only three moving parts.

PACKING GLANDS AND PACKING—A comprehensive handbook on industrial packing materials has been issued by Felt Products Mfg. Co., Chicago, This handbook not only contains descriptions and lists of uses for which each material is suited, but also includes samples of 36 different materials. In addition to felt, the materials employed alone and in combinations include asbestos, cork, aluminum, rubber, cloth, paper and leather.

WELDED PARTS AND EQUIPMENT—Linde Air Products Co., New York, is distributing a 20-page booklet on Oxweld No. 25M bronze welding rod. The booklet describes the physical and welding characteristics of the rod.

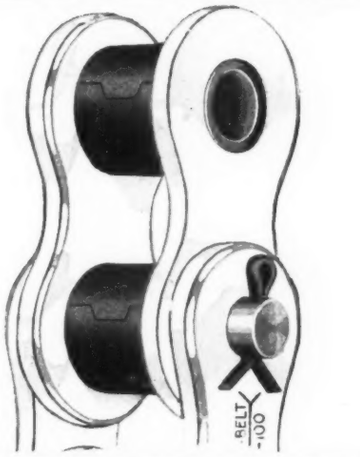
Research Publications

International Comparison of Electrical Standards, by George W. Vinal. This paper gives in detail the results of comparisons made by the national laboratories of Germany, England and the United States and shows that there are differences in the values of standard cells and resistances which are large enough to suggest the necessity for a readjustment of the units as maintained by the laboratories. Silver voltameter measurements were in good accord. Available through Superintendent of Documents, Government Printing office, Washington. 21 pp. 5 cents.

Effect of Casting Temperatures and of Additions of Iron on Bearing Bronze, by C. E. Eggenschwiler. A study made of the effect of different casting temperatures and of additions of iron upon the hardness, the structure and the resistance to wear, to pounding and to single blow impact of bearing bronze containing 80 per cent copper, 10 per cent tin and 10 per cent lead. Published by bureau of standards. Available through Superintendent of Documents, Government Printing office, Washington. 9 pp. 10 cents.

LINK-BELT
SILVERLINK
ROLLER CHAINS

IN presenting Link-Belt Silverlink Roller Chain, we are offering a product that represents the highest point of accomplishment in roller chain development. We have constantly improved our product since the inception of the Link-Belt organization back in 1875—57 years



ago—and it is due to our unending research work that we have maintained our position as the leader in the art of chain manufacture.

Built to the Highest Standards

All the qualities that have heretofore made Link-Belt Roller Chain so dependable have been retained in the Silverlink Chain. From raw material to finished product, tested and ready for service, every step in the chain manufacturing process is in our control.

The raw material is made to our exacting specifications. It is then carefully analyzed in our own laboratory. Each step in the manufacture of the chain thereafter is measured to the most exacting standards. The closest tolerances are maintained to secure uniformity and accuracy of pitch throughout the chain, so essential to long life and smooth operation in service.

Our unequalled heat treating facilities assure strength and toughness to the alloy rolled steel side bars and rollers, and correct case-hardening of the nickel steel pins, and the bushings. Every foot of Link-Belt Chain is tested under load for physical strength and wear value.

The sidebars of all Link-Belt Silverlink Roller Chains are especially treated to assist in resisting corrosion. Their silver color symbolizes the quality we have built into them.

Extensive Stock Service

Never before have we offered such a variety of chains, wheels and attachments, to suit practically every condition of service. With the large stocks carried in Link-Belt warehouses, and by distributors throughout the country, Link-Belt quality is instantly available to Roller Chain users.

In addition, we now have a much broader range of wheels available from standard patterns located at our several plants.

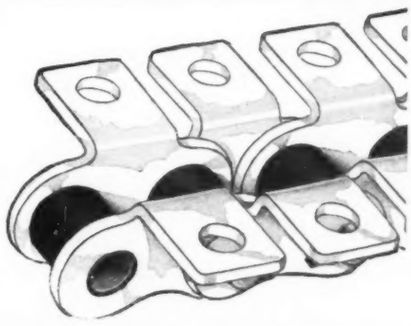
Roller Chains Constantly Improved

Roller Chains are not new. But their performance, efficiency, and long life have been bettered by improved materials, improved machinery for making the parts within the close limits demanded, improved technic and more accurate control of the heat-treatment, wider knowledge of chain action, and a better comprehension of proper sprocket wheel design. Roller Chain is in wide use today because designers and engineers recognize its distinct field of utility.

There is a correct use for each type of chain in industrial power transmission and conveying. Link-Belt makes every type of driving and conveying chain, and is, therefore, in a position to make unbiased recommendations as to the best type of chain for the particular conditions encountered. There is no one chain that is suited for all operating requirements.

Roller Chain for Power Transmission

Roller Chains should be used within their proper range of application, so as to give the maximum service per dollar invested. They



carry heavy loads at moderate chain speeds, with high efficiency, and are extremely durable and satisfactory in second-reduction drives and similar applications. They are particularly adaptable for intermediate, built-in drives, and for the coordination of the motion of widely separated shafts within a machine.

Roller Chain as a Conveying Medium

The use of Roller Chain as a conveying medium is rapidly increasing. It is exceptionally well suited for built-in systems in automatic machinery, and where accurate timing is desirable. By the use of attachment links, it is possible to fasten a wide variety of carrier members to the chain.

Next in efficiency and speed range to Link-Belt Silent Chain, Silverlink Roller Chain occupies an important place in the Link-Belt family of power transmission equipment. On high-speed drives where extreme smoothness of transmission is called for, the Link-Belt Silent Chain Drive is the better selection. It will last longer and run more quietly.

Study Each Application

Link-Belt Roller Chains furnish the sinews of power within the machine. They rarely serve as the connecting link between the driving motor and the machine. There are, however, places where Roller Chain can be used as a direct motor drive. Each application deserves a careful study of individual conditions, and of the qualifications of all of the various forms of power transmission available for the purpose. Where the input power must be supplied at a low r.p.m. compared with the speed of the driving motor, Link-Belt unit speed reducers, available in various types in speed ratios up to 1,000 to 1, may be the better choice; or, in reductions up to 20 to 1, the Silent Chain Drive will be found entirely practicable, and capable of rendering years of efficient service.

Roller Chain Is Reversible

Because Roller Chain is reversible and can be run on either side, it can be wound back and forth over a series of sprockets, where alternate directions of rotation are sought. The inherent flexibility of Roller Chains well suits them for various types of road building equipment, agricultural machinery, trucks, and other apparatus used over irregular terrain. The use of Roller Chains on trucks and tractors has proved their satisfactory performance in this trying service.

Made to Manufacturers' Standards

Roller Chains and wheels are made to Manufacturers' Standards approved by the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the American Gear Manufacturers' Association. This assures interchangeability.

The Link-Belt wheel tooth form is designed to compensate for increase in pitch due to natural chain wear. Should wear become serious, this form of drive is easily serviced.

Link-Belt Service

Back of Link-Belt Silverlink Roller Chain stands the reputation of a company that has been serving the power transmission and materials handling equipment fields continuously for over 50 years. Accumulated in its files and engineering organization is a vast experience extending into all phases of industrial activity. This experience is at your service.

Link-Belt Chains and Wheels can be readily identified by this trade >———< mark.

This new 264 page Link-Belt Roller Chain Data Book No. 1457 is the most comprehensive roller chain catalog and engineering data book we have ever published.

LINK-BELT COMPANY
Leading Manufacturers of Positive Power Transmitting Equipment
519 N. Holmes Avenue, Indianapolis, Ind.
Offices in All Principal Cities 4637

SEAL YOUR BEARINGS *with* PERFECT OIL RETAINERS

FOR THIS DOUBLE-ACTING PROTECTION

The Perfect Oil Retainer is the cumulative result of more than half a century's experience by the world's largest processor of leathers for industrial use. The scientific spring design is the most efficient for its purpose that highly skilled engineers can devise.

The combination of this specially tanned and treated leather with the perfected coil spring provides an oil seal that will efficiently seal all lubricants by applying a light, but *uniform,* positive pressure of the packing on the shaft, and at the same time exclude dust, dirt, grit and all other abrasives from the bearings.

The leather will not disintegrate and allow fibrous material to work into the bearings. It is not harmed by mineral lubricants—becomes soft and flexible when oiled to permit free rotation of the shaft. It is unusually wear resisting as evidenced by repeated tests under actual load conditions in which Perfect Oil Retainers have run more than a million revolutions without showing a sign of wear.

Nothing but a leather seal can give you *so much* protection for *so little* cost. Details about your product sent to us on the coupon below will bring you valuable information on the sealing of your lubricants and adding to the life of your bearings.

. . . FILL OUT AND MAIL THIS COUPON TO . . .

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Name of product_____ Shaft speed_____

Type of lubricant used_____ Shaft diameter_____

NAME_____ COMPANY_____

ADDRESS_____ CITY_____

NEW YORK DETROIT CLEVELAND PHILADELPHIA PITTSBURGH